October/November, 1974 Price, $1.75

Technology Review

Edited at the Massachusetts Institute of Technology

WHAT NEXT IN ELECTRONIC MATERIALS ?

technology
review
Published by MIT

SPECIAL REDUCED ALUMNI RATES

ELEVENTH ANNUAL TOUR PROGRAM—1975

1975 marks the eleventh year of operation for this unique program of tours, which visits some of the world's most fascinating areas and which is offered only to alumni of Harvard, Yale, Princeton, M.I.T., Cornell, Univ. of Pennsylvania, Columbia, Dartmouth, and certain other distinguished universities and to members of their families. The tours are designed to take advantage of special reduced fares offered by leading scheduled airlines, fares which are usually available only to groups or in conjunction with a qualified tour and which offer savings of as much as $500 over normal air fares. In addition, special rates have been obtained from hotels and sightseeing companies.

The tour program is consciously designed for persons who normally prefer to travel independently and covers areas where such persons will find it advantageous to travel with a group. The itineraries have been carefully constructed to combine as much as possible the freedom of individual travel with the convenience and savings of group travel. There is an avoidance of regimentation and an emphasis on leisure time, while a comprehensive program of sightseeing ensures a visit to all major points of interest.

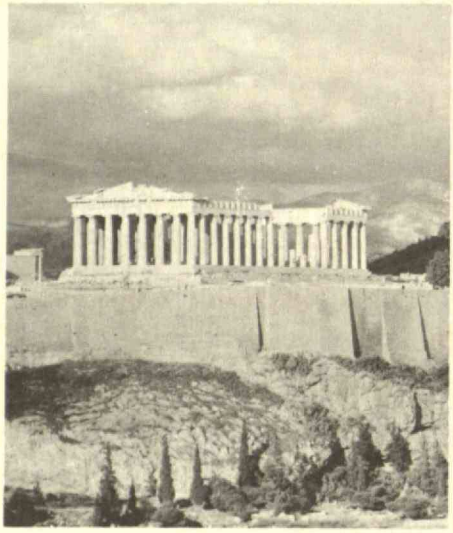
Each tour uses the best hotel available in every city, and hotel reservations are made as much as two years in advance in order to ensure the finest in accommodations. The hotels are listed by name in each tour brochure, together with a detailed day-by-day description of the tour itinerary.

The unusual nature and background of the participants, the nature of the tour planning, and the quality of the arrangements make this a unique tour program which stands apart from the standard commercial tour offered to the general public. Inquiries for further details are invited.

THE ORIENT

29 DAYS $2250

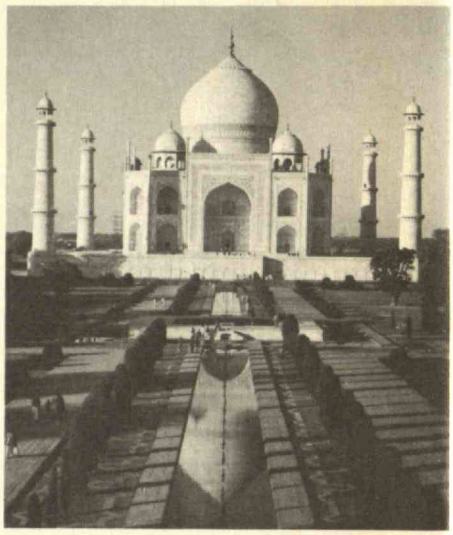
A magnificent tour which unfolds the splendor and fascination of the Far East at a comfortable and realistic pace. Eleven days are devoted to the beauty of JAPAN, visiting the modern capital of TOKYO and the lovely FUJI-HAKONE NATIONAL PARK and placing special emphasis on the great "classical" city of KYOTO (where the splendor of ancient Japan has been carefully preserved), together with excursions to historic NARA, the great medieval shrine at NIKKO, and the giant Daibutsu at KAMAKURA. Also included are BANGKOK, with its glittering temples and palaces; the thriving metropolis of SINGAPORE, known as the "cross-roads of the East"; the glittering beauty of HONG KONG, with its stunning harbor and famous free-port shopping; and as a special highlight, the fabled island of BALI. Optional visits are also available to the ancient temples of ancient Java at JOGJAKARTA and to the art treasures of the Palace Museum at TAIPEI, on the island of Taiwan. Tour dates include special seasonal attractions such as the spring cherry blossoms and magnificent autumn foliage in Japan and some of the greatest yearly festivals in the Far East. Total cost is $2250 from California, with special rates from other points. Departures in March, April, May, June, July, September, October and November, 1975 (extra air fare for departures June through October).



AEGEAN ADVENTURE

22 DAYS $1795

This original itinerary explores in depth the magnificent scenic, cultural and historic attractions of Greece, the Aegean, and Asia Minor—not only the major cities but also the less accessible sites of ancient cities which have figured so prominently in the history of western civilization, complemented by a cruise to the beautiful islands of the Aegean Sea. Rarely has such an exciting collection of names and places been assembled in a single itinerary—the classical city of ATHENS; the Byzantine and Ottoman splendor of ISTANBUL; the site of the oracle at DELPHI; the sanctuary and stadium at OLYMPIA, where the Olympic Games were first begun; the palace of Agamemnon at MYCENAE; the ruins of ancient TROY; the citadel of PERGAMUM; the marble city of EPHESUS; the ruins of SARDIS in Lydia, where the royal mint of the wealthy Croesus has recently been unearthed; as well as CORINTH, EPIDAUROS, IZMIR (Smyrna) the BOSPORUS and DARDANELLES. The cruise through the beautiful waters of the Aegean will visit such famous islands as CRETE with the Palace of Knossos; RHODES, noted for its great Crusader castles; the windmills of picturesque MYKONOS; and the charming islands of PATMOS and SANTORINI. Total cost is $1795 from New York. Departures in April, May, July, August, September and October 1975 (extra air fare for departures in July and August).



MOGHUL ADVENTURE

29 DAYS $2195

An unusual opportunity to view the outstanding attractions of India and the splendors of ancient Persia, together with the once-forbidden mountain-kingdom of Nepal. Here is truly an exciting adventure: India's ancient monuments in DELHI; the fabled beauty of KASHMIR amid the snow-clad Himalayas; the holy city of BANARAS on the sacred River Ganges; the exotic temples of KHAJURAHO; renowned AGRA, with the Taj Mahal and other celebrated monuments of the Moghul period such as the Agra Fort and the fabulous deserted city of Fatehpur Sikri; the walled "pink city" of JAIPUR, with an elephant ride at the Amber Fort; the unique and beautiful "lake city" of UDAIPUR; and a thrilling flight into the Himalayas to KATHMANDU, capital of NEPAL, where ancient palaces and temples abound in a land still relatively untouched by modern civilization. In PERSIA (Iran), the visit will include the great 5th century B.C. capital of Darius and Xerxes at PERSEPOLIS; the fabled Persian Renaissance city of ISFAHAN, with its palaces, gardens, bazaar and famous tiled mosques; and the modern capital of TEHERAN. Outstanding accommodations include hotels that once were palaces of Maharajas. Total cost is $2195 from New York. Departures in January, February, March, August, September, October and November 1975.

SOUTH AMERICA

32 DAYS $2275

From the towering peaks of the Andes to the vast interior reaches of the Amazon jungle, this tour travels more than ten thousand miles to explore the immense and fascinating continent of South America: a brilliant collection of pre-Colombian gold and a vast underground cathedral carved out of a centuries-old salt mine in BOGOTA; magnificent 16th century churches and quaint Spanish colonial buildings in QUITO, with a drive past the snow-capped

eks of "Volcano Alley" to visit an Indian rket; the great viceregal city of LIMA, nded by Pizarro, where one can still see arro's mummy and visit the dread Court of Inquisition; the ancient city of CUZCO, h in the Andes, with an excursion to the ulous "lost city" of MACHU PICCHU; smopolitan BUENOS AIRES, with its wide eets and parks and its colorful waterfront trict along the River Plate; the beautiful gentine LAKE DISTRICT in the lower ches of the Andes; the spectacular IGUASSU LLS, on the mighty Parana River; the sun-nched beaches, stunning mountains and gnificent harbor of RIO DE JANEIRO nsidered by many the most beautiful city in world); the ultra-modern new city of RASILIA; and the fascination of the vast mazon jungle, a thousand miles up river at ANAUS. Total cost is $2100 from Miami, 200 from New York, with special rates from her cities. Optional pre and post tour visits to nama and Venezuela are available at no addi-nal air fare. Departures in January, February, ril, May, July, September, October and vember 1974.

THE SOUTH PACIFIC

29 DAYS $2350

An exceptional and comprehensive tour of AUSTRALIA and NEW ZEALAND, with ptional visits to FIJI and TAHITI. Starting on he North Island of New Zealand, you will visit he country's major city of AUCKLAND, the reathtaking "Glowworm Grotto" at WAITOMO, and the Maori villages, boiling eysers and trout pools of ROTORUA, then fly o New Zealand's South Island to explore the tartling beauty of the snow-capped SOUTHERN ALPS, including a flight in a pecially-equipped ski plane to land on the asman Glacier, followed by the mountains and akes of QUEENSTOWN with a visit to a sheep station and a thrilling jet-boat ride through the canyons of the Shotover River. Next, the haunting beauty of the fiords at MILFORD SOUND and TE ANAU, followed by the English charm of CHRISTCHURCH, garden city of the southern hemisphere. Then it's on to Australia, the exciting and vibrant continent where the spirit of the "old west" combines with skyscrapers of the 20th century. You'll see the lovely capital of CANBERRA, seek out the Victorian elegance of MELBOURNE, then fly over the vast desert into the interior and the real OUTBACK country to ALICE SPRINGS, where the ranches are so widely separated that school classes are conducted by radio, then explore the undersea wonders of the GREAT BARRIER REEF at CAIRNS, followed by a visit to SYDNEY, magnificently set on one of the world's most beautiful harbors, to feel the dynamic forces which are pushing Australia ahead. Optional visits to Fiji and Tahiti are available. Total cost is $2350 from California. Departures in January, February, March, April, June, July, September, October and November 1974.

MEDITERRANEAN ODYSSEY

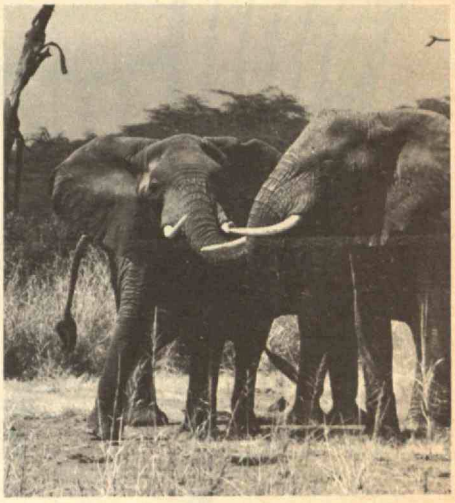
22 DAYS $1450

An unusual tour offering a wealth of treasures in the region of the Mediterranean, with visits to TUNISIA, the DALMATIAN COAST of YUGOSLAVIA and MALTA. Starting in TUNIS, the tour explores the coast and interior of Tunisia: the ruins of the famed ancient city of CARTHAGE as well as the ruins of extensive Roman cities such as DOUGGA, SBEITLA, THUBURBO MAJUS and the magnificent amphitheater of EL DJEM, historic Arab towns and cities such as NABEUL, HAMMAMET, SOUSSE and KAIROUAN, the caves of the troglodytes at MATMATA, beautiful beaches along the Mediterranean coast and on the "Isle of the Lotus Eaters" at DJERBA, and desert oases at GABES, TOZEUR and NEFTA. The beautiful DALMATIAN COAST of Yugoslavia is represented by SPLIT, with its famed Palace of Diocletian, the charming ancient town of TROGIR nearby, and the splendid medieval walled city of DUBROVNIK, followed by MALTA, with its treasure house of 17th and 18th century churches and palaces, where the Knights of St. John, driven from the Holy Land and from Rhodes, withstood the epic seige of the Turks and helped to decide the fate of Europe. Total cost is $1450 from New York. Departures in March, April, May, June, July, September and October, 1974 (additional air fare for departures in June and July).

EAST AFRICA

22 DAYS $1799

The excitement of Africa's wildlife and the magnificence of the African landscape in an unforgettable luxury safari; game viewing in the wilderness of Kenya's Northern Frontier district at SAMBURU RESERVE; a night at world-famous TREETOPS in the ABERDARE NATIONAL PARK; the spectacular masses of



pink flamingos at LAKE NAKURU; multitudes of lion, zebra, wildebeest and other plains game in the MASAI-MARA RESERVE and the famed SERENGETI PLAINS; the great permanent concentrations of wildlife in the NGORONGORO CRATER; tree-climbing lions along the shores of LAKE MANYARA in the Rift Valley, photographing rhino and other big game against the majestic snow-covered background of Mt. Kilimanjaro in the AMBOSELI RESERVE; and the vast and fascinating wilderness of TSAVO NATIONAL PARK, renowned for its elephant and lion and for the unusual desert phenomenon of the Mzima Springs. There is also a stay in NAIROBI, the most fascinating city in East Africa, as well as features such as a visit to a MASAI MANYATTA to see tribal dancing and the tribal way of life. Total cost is $1799 from New York. Optional visits are available to the VICTORIA FALLS, to UGANDA, and to ETHIOPIA. Departures in January, February, March, May, June, July, August, September, October, November and December 1974 (extra air fare for departures in June, July and August).

* * *

Rates include Jet Air, Deluxe Hotels, Most Meals, Sightseeing, Transfers, Tips and Taxes.

Individual brochures on each tour are available, setting forth the detailed itinerary, departure dates, hotels used, and other relevant information. Departure dates for 1975 are also available.

For Full Details Contact:

ALUMNI FLIGHTS ABROAD
White Plains Plaza
One North Broadway
White Plains, N.Y. 10601

INSIGNIA FAVORITES

THE M.I.T. CHAIR. A traditional favorite made of selected northern hardwoods and finished in satiny black with gold trim and gold M.I.T. crest. In all black or black with cherry arms. each **66.00**
Red and grey Duraleather Chair Cushion, foam filled. **12.00**

M.I.T. INSIGNIA TIE. A distinctive way to show off the M.I.T. shield. Fine quality polyester with repeat pattern on maroon or navy ground. 4″ wide. **6.00**

M.I.T. GLASSWARE. Fired-on silver Tech crest with chip-resisting platinum rim. Hi-ball, **1.75** each or **20.50** dozen; Double Old Fashioned, **1.85** each or **21.50** dozen; Single Old Fashioned, **1.60** each or **18.50** dozen.

PERSONALIZED PLAQUE. Cast bronze M.I.T. emblem mounted on solid walnut shield or rectangle. Available with bronze nameplate handsomely engraved with graduate's name and year of graduation. **25.95**
M.I.T. PLAQUE without nameplate. **21.95**

DIRECTOR'S CHAIR. Sturdy folding hardwood frame in natural or black finish. Seat and back in heavy white cotton duck with 3-color M.I.T. seal. **28.95**

DIRECTOR'S CHAIR with walnut frame. **31.90**

TR-1973

the Coop

M.I.T. Student Center
84 Massachusetts Avenue
Cambridge, Mass. 02139

Quan.			TOTAL PRICE
____	M.I.T. Chair, cherry arms	Express Collect 66.00	____
____	M.I.T. Chair, all black	Express Collect 66.00	____
____	M.I.T. Chair Cushion	12.00	____
____	M.I.T. Insignia Tie in navy	6.00	____
____	M.I.T. Insignia Tie in maroon	6.00	____
____	Hi-ball Glasses 1.75 ea. or 20.50 doz.		____
____	Single Old Fashioned 1.60 ea. or 18.50 doz.		____
____	Double Old Fashioned 1.85 ea. or 21.50 doz.		____
____	Director's Chair ( ) natural, ( ) black	28.95	____
____	Director's Chair in walnut	31.90	____
____	Plaque without nameplate	21.95	____
____	Plaque with nameplate ( ) Shield, ( ) Rectangle	25.95	____

Name to be Engraved _____
Class of _____

ALL PRICES SUBJECT TO CHANGE WITHOUT NOTICE

Please ship to: _____
Street _____ City _____
State _____ Zip _____
Ordered by: _____
Street _____ City _____
State _____ Zip _____
COOP # _____
☐ CHARGE MY ACCOUNT ☐ OR I ENCLOSE REMITTANCE

Mass. Residents: Add 3% sales tax (except ties).
Out-of-state Residents: No tax except when delivered in Mass.
(Make Checks Payable to the Harvard Cooperative Society)

SHIPPING AND HANDLING IN CONTINENTAL UNITED STATES

		EAST	MID-WEST	WEST
Director's Chair, Glassware and Plaque	(per order)	1.50	2.50	3.50
M.I.T. Chair Cushion	(per order)	.80	1.20	1.50
M.I.T. Insignia Tie	(per order)	.60	.60	.60

M.I.T. Chairs: Shipped Express Collect from Gardner, Mass.
Please allow approximately 16 weeks for delivery.

Edited at the
Massachusetts Institute of Technology

Volume 77, Number 1
October/November, 1974

Technology Review

Technology Review, Reg. U.S. Patent Office, is published eight times each year (in October/November, December, January, February, March/April, May, June, and July/August) at the Massachusetts Institute of Technology; two special editions are provided for graduate (pp. 1-120) and undergraduate (pp. 1-152) alumni of M.I.T. Technology Review is printed by the Lew A. Cummings Company, Manchester, New Hampshire. Second class postage paid at Boston, Mass., and at additional mailing offices.

Inquiries regarding editorial contents, subscriptions, and advertising should be addressed to: Technology Review, Room E19-430, Massachusetts Institute of Technology, Cambridge Mass., 02139. Telephone area code (617) 253-4872.

Price: $1.75 per copy, $12 per year in the United States, Canada and Mexico, $22 overseas. Please allow three weeks for changes of address, and give both old and new addresses in all requests.

Technology Review is represented for advertising by: Littell-Murray-Barnhill, Inc., 60 E. 42nd Street, New York, N.Y., 10017, telephone (212) 867-3660; Cole, Mason and Deming, 221 No. LaSalle Street, Chicago, Ill., 60601, telephone (312) 641-1254; Zander, Coughlin and Thompson, 5478 Wilshire Boulevard, Los Angeles, Calif., 90036, telephone (213) 938-0111 and 22 Battery Street, San Francisco, Calif., 94111, telephone (415) 398-4444.

Publisher
Donald P. Severance

Board of Editors
John I. Mattill (Editor), Dennis L. Meredith, Michael Feirtag, Sara Jane Neustadtl, Christine C. Santos

Production
Kathleen B. Sayre

Assistant Editor
Marjorie Lyon

Advertising
Richard F. Wright (Manager), Garnette E. Mullis

Circulation
Joseph J. Martori (Director), Dorothy R. Finnerty

Articles

Departments

The First Line

New Names on the Masthead

As we open Volume 77, *Technology Review*'s masthead (opposite) is different in two respects—a new form, and two new names.

The new form—the identification of a Board of Editors without the usual "Managing," "Associate," and "Assistant" designations—is intended to suggest that our editorial office is a horizontal, not a vertical or hierarchical, enterprise; we simply hope that the magazine represents the best that each of us with editorial responsibilities can bring to it, singularly and collectively.

The new names are those of Dennis L. Meredith and Christine C. Santos.

Mr. Meredith, formerly Assistant Director of the M.I.T. News Office, has a background of academic work in biochemistry and science writing at the Universities of Texas (B.S. 1968) and Wisconsin (M.S. 1970). Before coming to M.I.T. in 1973 he was for three years Science Editor at the University of Rhode Island.

Mr. Meredith is co-author (with psychologist Henry Biller) of *Father Power*, to be published early next year by David McKay Co. He holds a Westinghouse Science Writing Award from the American Association for the Advancement of Science and a Certificate of Special Recognition from the Atomic Industrial Forum for "Nuclear Power Plant Siting: a Handbook for the Layman," written in 1972 at the University of Rhode Island; and he is a member of the National Association of Science Writers.

Ms. Santos graduated in music and English at Wellesley in June, 1974; but she took her entire last year of undergraduate work at M.I.T. and for part of that time served as a teaching assistant in poetry in the Department of Humanities. She also found her way onto the M.I.T. women's crew, where in one year she earned a varsity letter as coxswain. Her assignment at the *Review* is to capitalize on this background in reporting on the Institute's many-sided community activities.—*J.M.*

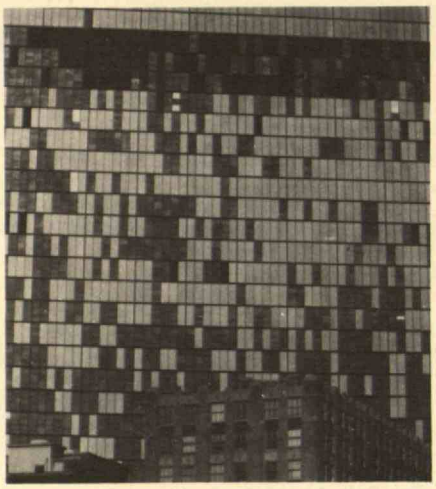
D. L. Meredith

Letters

The Engineer Is but Human

I particularly like Kenneth E. Boulding's (*see p. 8, June issue*) comfort in "the spectacle of engineers being caught out," and in token of my pleasure send the photograph (below) of the John Hancock Building in Boston.

Edward C. Cohen
New York, N. Y.



In the June issue, Kenneth E. Boulding mentions Murphy's law and evolution almost in the same breath, as if they were compatible. The truth is that they are not. In fact, a corollary of Murphy's law is that evolution is preposterous.

Murphy's law says that if anything can go wrong, it will. This law was apparently discovered by engineers. Now, if we engineers have so much trouble creating things that will work, *when we work so hard at it*, how can we think that the intricate mechanisms of nature will come to work, *by chance*? And we have not yet succeeded in making intricate mechanisms in such small spaces as, for example, the human eye, the sonar in bats, or the light generator in fireflies.

Moreover, there is the huge problem of maintenance. Even if we get something to work, we have to worry continually about keeping it working. But the aerodynamic functions of birds keep working for years without apparent maintenance or repair, and flowers bloom each year on schedule. Surely nature is not a closed thermodynamic system where entropy continually increases, and chaos eventually results. In fact, we read in the letter to the Hebrews that the Son of God, by whom the world was created, also upholds the universe by the word of his power.

The meek who will inherit the earth are not those who are the adaptable, as Mr. Boulding says, but those who are willing to accept the truth concerning the Son of God.

John L. Doane
Millburn, N. J.

Professor Boulding, who insists that "some of my best friends are engineers," warns that his columns are intended to be "rather light and ironic." He adds:

There is, of course, a corollary to Murphy's Law: If anything can go right, it eventually will, also. I was trying to point out the importance of improbable events in the evolutionary process, which covers a long period of time. The question of whether natural selection is a sufficient process to produce the amazing multiplicity of the present world is, I think, a legitimate question; but the only answer may be that of faith. The reconciliation of the language of religion and the language of science—a sensitive and delicate problem—is something which concerns me very deeply.

Msing the Point

I feel Ms. McKnight (*see "Sexism in Advertising: What's a Nice Girl Like You . . .", May, pp. 20-21*) is looking for an insult that isn't there. One of the most puzzling aspects of her report is the apparent idea that professionalism and femininity are irreconcilable. Are they really so diametrically opposed, or are they just that way in her mind? Or is the confusion due to the fact that femininity is not a static quality, but rather one that varies over time and space as people's needs change?

James A. Dirko
Everett, Mass.

You presented a very reasonable argument against sexist advertising, and I feel your rationale can be accepted by both male and female readers. Those of us in the working world will continue to help break down the barriers against women and, hopefully, without the alienation of the men.

Virginia O. Popejay
Streamwood, Illinois

The only reason I read Diane McKnight's article was because my attention was drawn to it by the "cleavage exposed" in one of the illustrations.

James R. Ort
Kenmore, New York.

Setting the Record Straight

A long-time experience in producing and applying energy gives one an excellent feel for the present energy situation. I am most impressed with the articles you have been running on energy and materials. There are so many superficial or slanted articles in the press that it is good to have your contributions to set the record straight on the correct scientific, engineering, and economic basics involved. . . The public must be brought into the picture so that we can all unite in holding the feet of our government officials to the fire and compel the necessary action to save us from "Finlandization." More power to you and your efforts.

John L. McEachin
Boca Raton, Florida

Letters continued on p. 96

When you see a tungsten filament glowing white-hot inside an electric bulb, you get some inkling of the tremendous temperatures tungsten can take.

Molybdenum isn't very far behind.

Both metals are great for electronic applications because of their heat resistance, strength and other properties.

They have about the same coefficient of expansion as hard glasses, so they provide excellent glass-to-metal seals. They're in solid-state all the way from the growing of single crystals to substrates for semiconductors.

Tungsten with its specific gravity of 19 is far heavier than lead. Use it for inertial parts.

Moly has very good electrical and thermal conductance at very high temperatures. So it's ideal for cathodes and heat sinks. It's also the lowest-cost refractory metal. And since it's fairly easy to machine, moly parts can be modestly priced.

We know these metals like our own brother, having worked with them for about 40 years. We make our own tungsten and moly powders out of our own pure chemicals and sinter them to meet your exact needs.

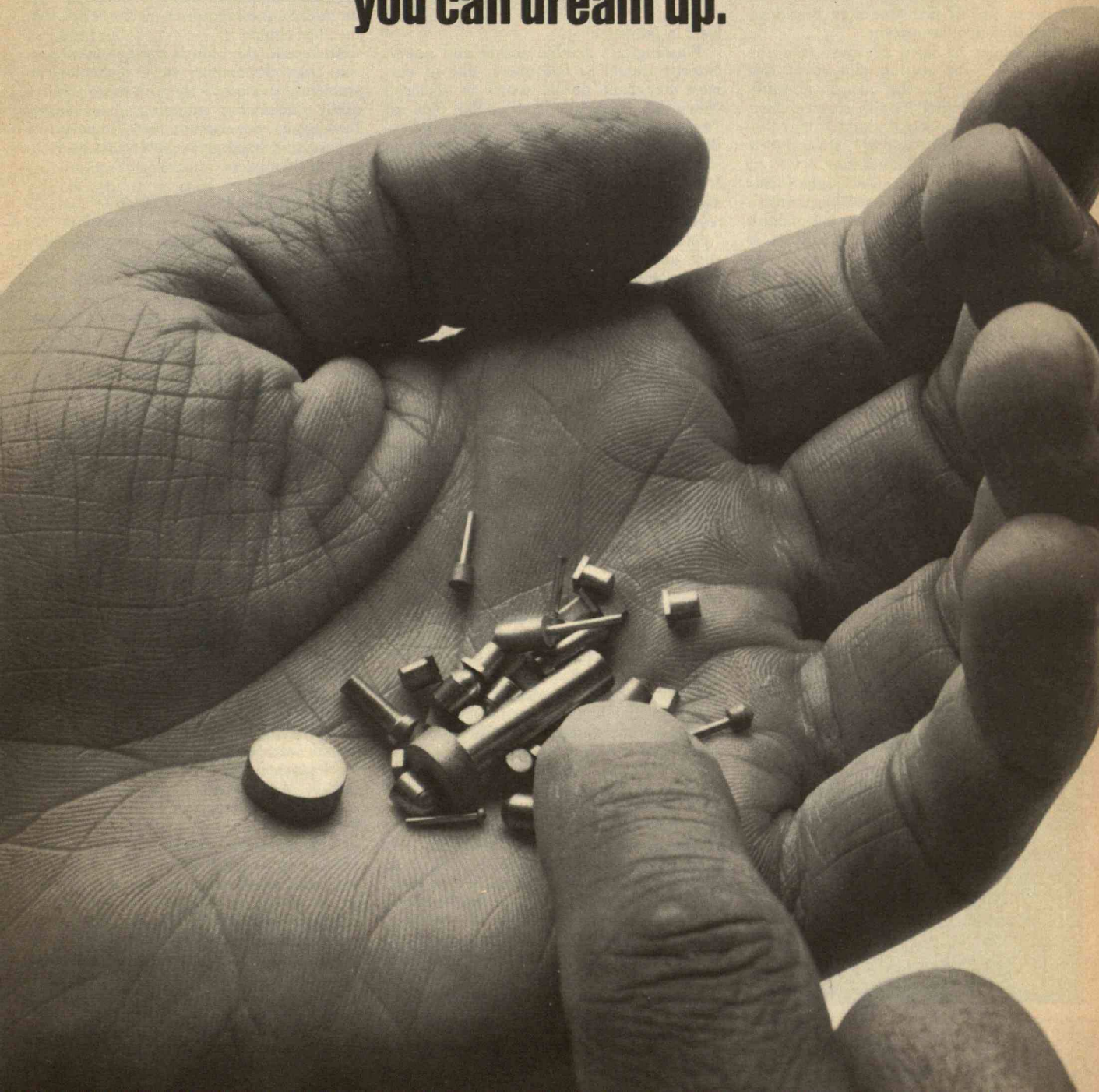
Tungsten and moly are available in simple forms—wires, discs, rods, coils, foils, plates. (We turn out small parts by the million.) We can also give you the most complex assemblies your heart desires.

Send us your sketch or design. We'll make your dream come true.

Write to: GTE Sylvania, Chemical & Metallurgical Division, Towanda, Pa. 18848. Or call: 717-265-2121.

GTE SYLVANIA

We'll give you any moly or tungsten geometry you can dream up.



Some Speculations on Science and President Ford

National Report
by
Victor Cohn

Will President Ford—his brief honeymoon with the nation long over and the nation's partly technological problems remaining—take some step toward restoring science to a place in White House councils?

While Vice President, he listened closely and sympathetically to advice that he do so. In his first weeks as President, he had to face other matters.

But sooner or later he must face the fact that, in the cutting phrases of Edward E. David, Jr., the man so abruptly dropped as Richard Nixon's science pilot, the Nixon years were marked by "benign neglect" and "apathy" toward science, and the country suffered.

Or so I believe. Also, so thought a National Academy of Sciences committee headed by James R. Killian, Honorary Chairman of M.I.T. It has called for a three-man Council for Science and Technology in the Executive Office of the President, a body to monitor government-wide use of technological expertise to solve problems.

Such a bid—though offered by the man whom a somewhat bewildered President Eisenhower summoned to help him with science after Russia shocked us with Sputnik—is not looked on with favor by everybody in Washington.

For the most part, it is not even looked on. The general reaction to scientists' ideas here remains apathy.

The Key Problem: Could Science Advice Help?

The principal committees dealing with science in Congress are either primarily space committees or committees that can lay claim to only one bit of science or another. No "science" committee or subcommittee has any real clout. Rep. John Davis of Georgia, Chairman of the House Science Subcommittee, who is a dedicated if ineffectual backer of a White House voice for science, was defeated in the primary in his District and won't even be back in January.

Washington's acerbic author and newsletterist Daniel S. Greenberg, one of our most trenchant public critics of science, views the Academy's and similar bids as "cogitations" of "the elders of the scientific community" who have been "banished from the throne room" by Mr. Nixon and are now engaged in "elaborate explanations" and "political" exercises to regain their authority. They have "quaffed too many heroic myths of science and government and . . . forgotten that science and technology represent a relatively narrow slice of any president's concerns," he wrote.

A *narrow* slice? Mr. Ford's two immediate predecessors may indeed have become little *interested* in their independent-minded scientists and engineers who shot down their cases for S.S.T.s and A.B.M.s. But one or both of these recent presidents were forced to be interested in energy, weaponry, environmental pollution, the weather, food and population, and a number of other interrelated areas which are giving us increasing trouble, in part because of widespread federal apathy and neglect to technological expertise.

The question should not be whether or not the people advocating a new White House Council for Science and Technology or some similar mechanism or even a cabinet-level Department of Science are properly classified as "elders" seeking to regain a place in the throne room.

Maybe they are and maybe they aren't. The important question is: Do they belong there?

Moreover, Dr. Killian and Philip Handler, the Academy's President, may indeed be scientific elders in age or prestige. But like-minded President Robert Seamans of the National Academy of Engineering is harder to classify. He is a kind of tough, practical professor-type who has demonstrated that he can readily move back and forth between the Massachusetts Institute of Technology and such demanding positions as Secretary of the Air Force.

Alan C. Nixon, until recently President of the American Chemical Society (who has formed and led a new Committee of Scientific Society Presidents agitating for policy-level science advice) is no establishment elder at all; he is a practical West Coast industrial chemist who successfully nominated himself and ran for the A.C.S. presidency in defiance of the chemical elders.

To repeat, the only important questions are: Does the country have technological problems, and could they be more intelligently faced by gathering more basic knowledge, developing more innovative attacks, and heeding technological as well as political advice?

Learning from a Time of Crisis?

David Beckler, a principal assistant to all the presidential science advisers, points out (in a recent issue of *Daedalus*) that "when in 1965 the White House science and technology mechanism urged action to deal with environmental problems before the lakes filled with algae, and to bring out a better balance between nuclear and fossil fuel research before the pressure of Arab intervention, there was little or no interest or response at the top of government."

Philip Abelson, the ever-fresh and original editor of *Science* who is also President of the Carnegie Institution (he is most decidedly neither a knee-jerk elder nor a habitual Jeremiah) writes: "The energy position of the United States continues to deteriorate, and Congress and the Administration provide few indications that they are going to do anything substantive about it quickly. . . ."

In an expected new Energy Research and Development Agency, Abelson notes, "the largest budget component [will be] for nuclear weapons production and development," the next largest for the civilian nuclear program, including the breeder reactor, with coal research and developments slated for only some 10 per cent of the budget, conservation 3 per cent, and geothermal and solar energy 1 per cent.

"The mountain labored and brought forth a mouse," he concludes. "A nation that could spend tens of billions of dollars on going to the moon is unable to spend a few billion of dollars on demonstration plants for meeting urgent needs. . . . Apparently we will have to endure a more jarring experience with crippling shortages before vigorous action can be taken."

Robert Cairns, Executive Director of the American Chemical Society, concluded during the "energy crisis" a year ago that "the technical competence to deal with the critical factors characterizing this new kind of crisis is not present in an influential way at the policy center of our government." He predicted a further series of technical crises to prove his point.

A developing food crisis is already with us, and a little-noticed National Advisory Committee on Oceans and Atmosphere has just told the government: "The ability to sustain our economy in the face of the fuel shortage this last winter, with only minor discomforts as a nation, was due largely to a spell of warm winter weather. What luck next time?"

Powerhouses Aroused . . .

Congress and the White House have, of course, been occupied with the Nixon crisis and the recent transition, and President Ford is just developing his own set of mechanisms and advisers. But President Ford has demonstrated that he is capable of acting quickly on issues when he chooses. He will probably do so on science (or just may have done something by the time that you read this) *if*, first, he is a President who really cares, and, second, he decides that Mr. Nixon's more-or-less pro-forma "science adviser," H. Guyford Stever, cannot be both an effective head of the National Science Foundation and an effective government-wide science watchdog.

Or Congress may yet act. Congressional feeling about the nation's lack of technological guidance extends well beyond the floundering science committees.

For example, Senators Warren Magnuson (D.-Wash.), Frank Moss (D.-Utah), and John Tunney (D.-Calif.) are authors of an amendment to a proposed Technology Resources Survey and Applications Act ordering establishment of a Council on Science and Technology much like the one suggested by the Killian Committee.

If President Ford does not act, this will not be the last such Congressional suggestion. When powerhouses like Magnuson get really aroused, things can happen.

Victor Cohn, whose reports appear regularly in this space in Technology Review, *reports on science and related issues for the* Washington Post.

"Consequential in Almost Every Function of Government"

The following are excerpts from the National Academy of Sciences report, "Science and Technology in Presidential Pol cymaking," the recommendations of an ad hoc *committee of the Academy chaired by James R. Killian, Jr., Honorary Chairman of the Corporation, M.I.T.:*

That science and technology are constantly transforming the world is manifest. Indeed, the process is so pervasive that its implications tend to be overlooked or neglected. For several hundred years, the growth of scientific knowledge and the development of new technologies have been changing the character of human life. Today, and for the foreseeable future, science and technology will continue to be the chief engine of change in our society.

The impact of science and technology on government steadily grows. Success in addressing many of the nation's most urgent problems must increasingly depend on the wise and benign use of science and technology. If the quality of our society and the aspirations of our people are not to be diminished, it is necessary to bring to bear the most competent and imaginative science and technology that the nation can muster.

We are quite aware that the burden of the Presidency is one of balancing conflicting interests and assessing trade-offs among alternative courses of action, which almost always carry with them both positive and negative consequences of technological development. . . . (Accordingly), we are persuaded that the Office of the President can benefit from some substantial institutional mechanism for dealing with the scientific and technical aspects of major issues that must be resolved at the Presidential level.

The fundamental thesis of this report is that the process of summation that takes place at the level of the Presidency requires accessibility of scientific, technological, and engineering counsel at that level. . . . Such interaction (is) necessary to identify problems and opportunities calling for scientific and technical judgments and to assure that, as policy takes shape, the scientific and technical considerations will be given their appropriate weight and the full range of technical options presented, from among which policymakers may decide in a fully informed manner.

. . . Scientific and technical counsel possesses exactly the kind of generality that is required at the highest levels of policymaking: general in the sense that it is likely to be consequential in almost every function of government. . . . We (therefore) recommend that a Council for Science and Technology be established as a staff agency in the Executive Office of the President.

We live in a century of science and technology, driven by man's situation and his aspirations, and we are moving toward a future of more science and more technology. What we have sought to promote in this report is one means, among many means that will be necessary, to make science, technology, and engineering more responsive to human needs.

Reflections on Planning: The Value of Uncertainty

Economics/Society/Technology
by
Kenneth E. Boulding

I have been involved lately in a committee which is thinking about planning for my university, so I have been forced to think about planning myself. Planning is a good or a bad word depending to a considerable degree, I suspect, on whether one is doing the planning or whether one is being planned. My reflections on the subject have taken the form of twelve rather haphazard propositions, none of which I put forward as being necessarily true, but which are perhaps plausible enough to be worth investigating.

1. The world moves into the future as a result of decisions, not as a result of plans. Plans are significant only in so far as they affect decisions. Planning may be defined in such a way that it is part of the total decision-making process; but if it is not part of a decision-making process, it is a bag of wind, a piece of paper, and worthless diagrams.

2. Planning as part of the decision-making process may be defined as any conscious intellectual activity resulting in communications to decision-makers which is considered successful if future decisions are improved.

3. It is by no means easy to say what we mean by improving future decisions, although the concept does not seem to be meaningless. This is because the "goodness" of a decision is hard to evaluate, and still harder to measure. Thus, unless we can have some measure of the "goodness" of decisions, it is very hard to know which direction constitutes improvement—that is, which way is up. One possible measure is the amount of regret which is generated by looking back on past decisions. In this sense, the success of planning might be measured by the extent to which it diminishes regret, especially considered and carefully examined regret. This is something about which busybody social scientists might conceivably ask people, and so it is hypothetically measurable.

4. All decisions involve the evaluation of alternative images of the future, and the selection of the most highly valued feasible alternatives. Decisions, therefore, involve two elements: An *agenda* consisting of alternative images of the future with degrees of uncertainty applied to each and an image of the relation between present action and the future trajectory. Then, in addition, there must be a *valuation scheme* from which comes a preference ordering at least sufficient to identify the best elements of the agenda, which is presumably what is chosen.

5. Both agendas and valuation schemes are mainly learned by the decision-maker from past information input. What is usually called "planning" is an activity which produces the product of planners, which takes the form of some kind of communication. This is usually only a small part of the total information input of decision-makers, and there is no certainty that its impact is positive for producing better decisions rather than worse. The study of the effects of the planner-product has been much neglected.

6. Evaluation and decision strategy, and the quality of decisions in general, depend very much on the degree of uncertainty of the items on the agenda. The greater the uncertainty of the agenda, the higher the value which should be placed on decisions which leave future options open—that is, on "liquidity" and noncommitment. Decision-making under high degrees of uncertainty is a very different kind of beast from decision-making under low degrees of uncertainty. Decision-making under conditions of absolute certainty is unknown in the real world.

7. An important source of bad decisions is illusions of certainty, which often lead to decisive action which zeros in on disaster. The great danger is that the product of planning frequently produces illusions of certainty simply because it is dressed up so prettily. Planners often dislike uncertainty, and decision-makers dislike uncertainty even more and so tend to neglect the uncertainty which may be in small print in the planner-product.

8. Computerized and numerical models, especially those with fancy diagrams and print-outs, are almost certain to produce illusions of certainty and may therefore easily lead to bad decisions. A study of computer-induced disasters, from bankruptcies to wars, is much overdue; we do not seem to have techniques for understanding uncertainty in the context of computerized models.

9. From the point of view of the quality of the total decision-making process, as measured by how much in general things go from bad to better rather than from bad to worse, there are optimum degrees of inefficiency and ignorance, and an optimum degree of decentralization. When efficiency leads to a loss of adaptability, and information leads to illusions of certainty, and centralization leads to both of these, we have a magnificent design for extinction. Under some circumstances the reports of planners may increase the chance of extinction in these ways.

10. But the product of planning could be quite consciously designed to increase the chance of making better decisions. The most valuable products might be:
—The widening of agendas—that is, helping the decision-maker to think of things not already thought of; narrowing of agendas is often an important source of bad decisions. If anybody says, "I have no alternative," you know something has gone wrong.
—The examination of values and the critique of value-indicators—that is, objective functions. Planner-product might be able to help decision-makers who ask "Do I really want X?" (X may mean getting bigger, or richer, or more noticeable, etc.).

11. Planner-product might improve decision-making also if it included some things which are not now usually included—such as the study of past bad decisions, early-warning signals, the failure of past predictions, etc.—which might improve the cue system of the decision-maker. Not enough thought has been given to the question of what planner-product would be most helpful.

12. Planning is probably most useful in organizations with rather simple objectives such as making money. The only thing that prevents planning from being disastrous in government is that it is not usually believed, governments being multi-purpose, multi-objective organizations. Indeed, planning is likely to be particularly disastrous in universities where the optimum degree of inefficiency and decentralization is very large and where the objectives cannot be expressed by any single algorithm. Quantification and computerization can lead to general decay in this situation.

Kenneth E. Boulding, who was born in England and educated at Oxford University, is Professor of Economics at the University of Colorado and Director of the Program on General, Social, and Economic Dynamics at the University's Institute of Behavioral Science. He is a regular contributor in this space to Technology Review.

M.I.T. QUARTER CENTURY CLUB

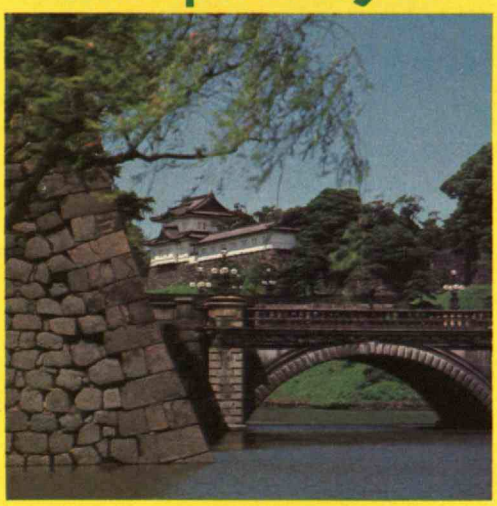
ORIENT

UNBELIEVABLY

$459**

plus 15% tax and service

A Nine Day Japan Trip
With Options Beyond



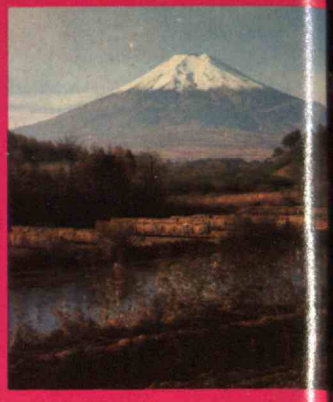
Departs approx 12:30 A.M.

Returns approx 7:30 P.M.

(above times subject to change)

Departing from Boston Wednesday, January 22
Returning to Boston Thursday, January 30



FOR A PRICE SO INCREDIBLY LOW WE MIGHT GO AGAIN,

we are deserting the Western Hemisphere for a charter-flight vacation to the earth's other side, entering the culture of half the world's people with its ancient dynasties, floating villages, soaring pagodas, and gilded palaces. We'll dwell in the land of the rising sun, of the August moon and the haiku poem, where cherry blossoms fill quiet, sculptured gardens and snow-capped volcanic peaks slope to the sea. Here Geishas in kimono, with parasol and fan, ride the ageless rickshaw to a teahouse rendezvous; here the Samurai warrior lives on in martial arts; here Confucius and the Buddha are man's stepping stones to wisdom; here the visual art is found on silk or in a woodblock print. Here gentle people still bow on meeting, remove their shoes on entering a home, sit on the floor while dining from low tables, and enjoy their bathing in a communal way. We're going to the Orient's very largest city, indeed the largest in the entire world; we're visiting one of the world's great nations, America's foremost Asian ally.

OUR ORIENT VACATION IS PLANNED TO INCLUDE:

- **Round-trip Jet Flights** between the city of departure in the United States and Tokyo, Japan, via a large, four-engine DC-8 jet of America's Trans International Airlines, the world's most experienced charter airline, with a perfect passenger safety record of over 25 years.

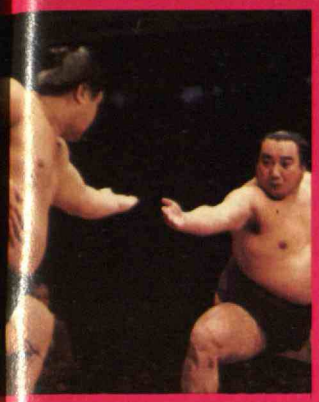
- **Upon Arrival and Departure, Deluxe Motorcoach Transportation for Persons and Luggage** between the airport in Tokyo and our hotel, including porterage of luggage into and out of hotel rooms.

- **A Japanese Welcome Party,** for the entire group on arrival, featuring sake or scented tea. Hosted by our International Weekends, Inc. tour personnel, the gathering will give us the chance to make new friends and plan our activities.

- **Hotel Accommodations for 8 days and 7 nights** at Sheraton's* magnificent New Otani Hotel. Our spacious, bright rooms all have double or twin beds, private bath and shower, television, private telephone, radio, air conditioning, and a fabulous view of Tokyo. *A Sheraton Referral Hotel.

- **Breakfast Each Morning,** consisting of coffee or tea and fresh pastries and rolls, a lovely way to start each day.

- **A Half-Day Motorcoach Sightseeing Tour of Tokyo,** with English-speaking guide, will show us important sights such as *the 17th-century Imperial Palace with its surrounding moat; the Kabukiza Theater; Meiji Shrine (dedicated to the 19th-century Emperor); the Korakuen Garden (classical Japanese); Kokogikan Sumo Stadium (home of the world-famous wrestling matches); Shofu Flower Arranging School; the Akasaka nightlife district with its many tea and Geisha houses; Bonsai Village with its miniature trees and shrubs; the Tasaki Pearl Gallery; the Koshikawa Botanical Gardens; Rakanji Temple (with 300 beautiful gilded statues); the Public Baths; Watanabe Woodblock Print Shop; the Paper Museum (paper-making process and products); Junk Park (where old vehicles are transformed into playground equipment); the Silk Museum (the silk-making process and historic costumes); Jindai Flower Garden; Sugino Gakuen Costume Museum (Kabuki and Noh costumes); Ueno Amusement Park (with the Zoological Gardens and Aquarium); Kokusai Theater; Tokyo Tower (commanding a spectacular*




view of Mt. Fuji); the Science Museum; Nippon Budokan Hall (built for the Tokyo Olympics); Tokyo University; Hie Shrine; Meiji Outer Garden; the Treasure Museum; the National Diet Building (center of government power); the Ginza District (center of business and entertainment); Toshogu Shrine (with its magnificent 5-tiered pagoda); the Hama Detached Palace Garden; Sengakuji Temple; Tokyo Metropolitan Fine Art Gallery; Kanda Myojin (a vermilion-painted Shinto shrine); Goto Museum (a fine collection of Buddhist art); Shinjuku Gardens (with the largest greenhouse in Asia); Komazawa Olympic Park; the National Theater (staging classical dances and plays); Kitanomaru Park (housing the National Museum of Modern Art); Tokyo's World Trade Center; National Museum of Western Art (designed by Le Corbusier); and more . . . .

- **Tickets to Kabuki Theater,** one evening, introducing us to the spectacle of Japan's traditional drama.
- **A Special Group Origami Lesson** to instruct us in the Japanese fine art of paper folding.
- **A Japanese Fashion Show,** one day, allowing us to view (and buy) the exquisite kimonos, scarves, parasols, happy coats, wooden sandals ("getas"), and other costume unique to the Orient.
- **Admission to a Public Bath,** a chance to experience one of Japan's oldest traditions.
- **A Tea and Flower Arranging Ceremony,** one day, to demonstrate the ancient ritual of the tea ceremony and the art of flower arranging ("ikebana").
- **A Sumo, Judo or Karate Exhibition** to show us the excitement and precision of Japan's martial arts.
- **Special Shopping Discounts** to save money on our purchases of incomparable Japanese silks, pottery, cameras, electronic equipment, and fashions.
- **A Souvenir Oriental Fan,** in miniature, as a gift and memento for each passenger.
- **A Map of Tokyo and a Guide to Tokyo,** helpful information to facilitate our plans.
- **The Services of International Weekends, Inc. Tour Host Personnel** available to our group throughout the trip, well-informed people to advise and assist us as we may require.
- **"Tax and Service"** is included in the trip, meaning all taxes, tipping and service charges in connection with the land arrangements in Tokyo.

SHERATON'S NEW OTANI: ASIA'S LARGEST AND MOST FABULOUS RESORT HOTEL

One of the world's largest hotels, the centrally located, completely deluxe, 17-story New Otani, with its new 40-story adjacent tower, offers fabulous facilities including: Ten acres of traditional Japanese gardens surrounded by a moat and adorned with flowers, waterfalls, bridges, and the traditional teahouse Sixteen gourmet restaurants, featuring the finest in Japanese, Chinese and continental cuisine, including five restaurants atop the new 40-story tower Five lounges and a coffee shop, including the Blue Sky Lounge, a revolving lounge on the 17th floor of the main building Japan's largest hotel shopping arcade featuring 66 specialty shops Saunas, massage (even available through room service), beauty salon and barber shop Swimming pool with pool-side restaurant.

TWO DAYS IN HONG KONG & OTHER OPTIONAL SIDE TRIPS

Passengers may supplement their trip through the additional purchase of optional side trips (see back of this brochure) and/or the purchase of a $49 seven-dinner Dine-Around Meal Plan (details of which will be sent to each passenger before departure).

THE PRICE AND WHAT IT INCLUDES: The dollar amount shown on the front cover of this folder includes round-trip jet transportation (on charter flights) between the city of departure in the United States and Tokyo, Japan, transfers of persons and luggage, on arrival and departure, between the airport in Tokyo and the hotel, hotel accommodations, on a double occupancy basis, for seven nights in Tokyo at the New Otani or equivalent class hotel, coffee and pastry each morning, a welcome get-together, a half-day sightseeing tour of the city, a souvenir gift, a map and guide of Tokyo, shopping discounts, such group activities as may, in the discretion of the Travel Agent, be planned for the group, services to the group of Tour Host Personnel, and Tax and Service. The phrase "Tax and Service", as used in this folder, means and includes only taxes, tipping, and service charges with respect to the land arrangements in Japan (including a service charge imposed by the Travel Agent). The constitution of the total price of this trip (air transportation, land arrangements, and administration) and possible price fluctuations therefor are set forth elsewhere on the back of this folder. The items enumerated in the first sentence of this paragraph are expressed in general terms, because International Weekends, Inc. (the "Travel Agent") reserves the right, without having to refund any monies to the passengers, to alter, change or make substitutions in the trip, its itinerary, and its features provided that such alterations, changes or substitutions do not diminish the aggregate fair market value of what is to be included in the trip. The price of this trip does not include expenses of passports, visa fees, items of a personal nature such as laundry, telephone, food and beverage other than specifically included, United States airport departure tax, currently $3.00 (for which tax each passenger should be invoiced before departure), any Japanese departure tax, or any other item not specifically stated herein to be included in the price.

SINGLE RESERVATIONS: The amount stated on the front cover of the brochure is per person based on double occupancy of a hotel room. Single reservations require an additional charge of $99.

DOCUMENTS: Each passenger is responsible for obtaining and having with him a valid United States passport, a certificate of smallpox vaccination issued within three years preceding departure, and a Tourist Visa for travel in Japan. For a Visa Handling Fee, the Travel Agent will obtain the required Tourist Visa (a Visa Application Form will be sent to each passenger at the time his reservation is confirmed).

LUGGAGE: Each passenger on board the aircraft is limited to 44 lbs. of luggage, subject to the further limitation that he have not more than one suitcase and one small carry-on piece. Throughout the trip, luggage travels strictly at the risk of the passenger, and the Travel Agent shall not be responsible or liable for any delay in the transportation of, for any loss of, or for any damage to passengers' baggage (or its contents). Baggage insurance is available and recommended.

FINAL PAYMENT AND CANCELLATION: Payment of final balance is due sixty (60) days in advance of departure (at which time reservations will be confirmed). Reservations may only be cancelled by written notice sent by registered mail (return-receipt requested) to the Travel Agent. If such notice is received by the Travel Agent no later than sixty (60) days before departure, the Travel Agent will accept the cancellation and refund all monies. If such written notice is received within sixty (60) days before departure, the Travel Agent will accept such cancellation and refund monies only if the cancelling party finds eligible substitute(s) for the reservation(s) being cancelled. Cancellation insurance (protecting against the loss of airfare) is available and recommended.

ELIGIBILITY: Participation in this trip is limited to those persons who, for six months preceding departure, have been members of the organization whose name appears on the front cover of this folder, such members' husbands and wives, their dependent children, and their parents, if living in their households.

INSURANCE: Ordinary travel insurance is available.

OPTIONAL SIDE TRIPS

Here are a few of the inexpensive optional side trips available for purchase:

TWO DAYS IN HONG KONG
Fly to Hong Kong for two days at the Sheraton Hong Kong or equivalent.

OVERNIGHT IN THE REPUBLIC OF CHINA
Fly to Taipei for a day and a night in ancient China.

A DAY IN SOUTH KOREA
Fly in the morning to Seoul for a day in the "Land of Morning Calm," with return the same evening.

A DAY IN KYOTO
Ride the world's fastest "bullet" train for a full-day tour of Japan's centuries-old cultural center.

JAPAN'S HOT-SPRING PARADISE
A half-day tour to the lovely mountain resort area of Hakone.

SACRED MT. FUJI
A half-day tour to Japan's highest and most celebrated peak and the surrounding lake area.

A TRADITIONAL GEISHA PARTY
An exciting evening of Japanese songs, dances and games attended by lovely Geisha.

RESPONSIBILITY, ETC.: Each person making reservations for or participating in the trip described in this folder understands and agrees to all the terms, conditions, and limitations set forth in this folder including the following:

The air transportation for this trip is held out and engaged by the sponsoring organization whose name appears on the front cover of this folder, which organization acts as agent for the group of persons to be transported thereby. In endeavoring to make arrangements with various persons, firms, and corporations for the services and accommodations described in this folder to be included in this trip (or in any optional side trips offered in connection with this trip), International Weekends, Inc. (the "Travel Agent") acts strictly as agent for the air carrier in the case of the air transportation and as agent for the tour participants in the case of all other services. As an agent the Travel Agent shall not be responsible or liable for AND EXPRESSLY DISCLAIMS ANY RESPONSIBILITY OR LIABILITY FOR, any loss, cost, injury, expense or damage to person or property which results, directly or indirectly, from any act, whether negligent or otherwise, of commission or omission (including but not limited to delays), of any person, firm, or corporation which is to, shall, or does provide products or services in connection with the trip, including but not limited to transportation services (whether by air, sea, or land), lodging, food and beverage, entertainment, sightseeing, luggage handling or tour guiding or escorting. The Travel Agent reserves the right to decline, accept, or retain, at any time and for any reason, any person as a participant in the trip (or any optional side trip). If any person is removed by the Travel Agent from the trip (or from any optional side trip) a proportionate refund for unused services will be made. The Travel Agent reserves the right to cancel the entire trip (or any optional side trips offered in connection with the trip) for any reason at any time before departure of the trip (or side trip respectively), in which event the liability, if any, of the Travel Agent shall be limited to and liquidated by refunding to each prospective participant the monies, if any, theretofor received by the Travel Agent for such person's trip (or optional side trip, as the case may be), which monies have not been or should not be otherwise refunded to him.

**The price of this trip is constituted as follows: Air transportation, $360.94 per person; land arrangements, $163.91 per person; administration, $3.00 per person; total price, $527.85 per person.

The air fare stated above is a pro rata cost to each of 254 passengers; should there be fewer than 254 passengers, each passenger may, at least forty-five days before the departure date, be notified of any increased pro rata cost to him and will have the option to pay the difference or cancel without penalty.

The cost of the trip is based on the monetary exchange rate of U.S. Dollars to Japanese Yen as existed on June 1, 1974 and on tariffs, rates and costs in effect as of June 1, 1974; should there be, between then and the date of departure, an increase in such tariffs, rates or costs, each passenger may be required to pay an increased amount for the trip reflecting such increase.

THIS WAY TO THE ORIENT

TO:
Mr. Jack Newcomb
M.I.T. E-19 238
77 Massachusetts Avenue
Cambridge, MA 02139

MY CHECK IS MADE PAYABLE TO:
M.I.T. Quarter Century Club

Enclosed is $_____ ($200.00 per person) as deposit for _____ reservation(s) on the Orient trip, subject to the terms stated in this folder.

NAME(last) _____ (first) _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

TELEPHONE(9-5) AREA CODE_____NUMBER_____ (after 5) AREA CODE_____NUMBER_____

☐ I REQUEST A SINGLE ROOM ☐ I REQUEST A DOUBLE ROOM TO BE SHARED WITH

_____ (Name & Address)

I have attached a list of names, addresses, and telephone numbers of those persons for whom I am requesting reservations, and have indicated whether single or double accommodations are required.

JPN0123A-MIT

RESERVATIONS DEADLINE

November 20

INTERNATIONAL WEEKENDS, INC.
The Group Travel Specialists
120 Water Street
Boston, Massachusetts 02109
Telephone 617/723-8300
TELEX 94-0847 INTL WKNDS

Printed in U.S.A.

The Trouble With French Science Is Frenchmen

European Report
by
Grace Marmor Spruch

There are complaints in every country about the direction, uses, and non-uses of science. But some of the French ones are notably direct and outspoken; for example, a French government report proclaims that "French education, from elementary school to university and engineering school, is arranged to stifle the imagination, curiosity, creativity, and interest in technology that are fundamental to successful research."

Such a complaint touches problems that are rooted in the very life style of the country; simple changes of allocations and even of science policy will not be enough.

Science is much more related to "politics" in France than in the United States. For one thing, research is run to a very great extent by the government, and the motivations of the French government in supporting science are different from those of the U.S. government. In France, where the cultured man is a classicist, the motivation has been largely prestige: a major nation must have men prominent in science; the results to be derived from science are of lesser importance.

De Gaulle is credited with having tried to make French science more practical, to apply it to national purposes. His efforts, successful in some areas, were often frustrated by the inertia of centuries-old traditions. One result is that French industry still buys as much as 80 per cent of its patents instead of making its own inventions. Pierre Piganiol, who—as head of the *Délégation Générale à la Recherche Scientifique et Technique* in the early years of De Gaulle's government (1958-1962)—set up the structures for disbursing funds that still operate today, attributes this chiefly to the small size of the French home market and the relatively lower per capita income—compared at least to that in the U.S. "A Frenchman can't afford a freezer, so he doesn't demand one. That leads to a lower level of creativity in France. As the standard of living goes up, needs go up as well."

And with a larger industrial market the margin of profit is likely to be greater, and more money can be turned back into research. When M. Piganiol—now an adviser on long-term problems to the President of a venerable industrial giant, Saint Gobain—joined the De Gaulle government in 1958, 0.75 per cent of the gross national product was being spent on research and development. The figure went to about 2.3 per cent, or about $2.5 billion a year in 1969, and is now about 1.8 per cent. (The U.S. figure was 3.4 per cent in 1965 and is now about 2.6 per cent.

There are exceptions to the low-profit, small-size situation in French industry. For example, as France is predominantly an agricultural country, there is a good home market for fertilizer, and the fertilizer industry is highly developed with an enlarged capacity for research, which is about 5 per cent of sales. The electronics industry spends something like 10 per cent on research, roughly the same as in the U.S.

High Marks for the Inapplicable

A lengthy government review of the state of French science and technology gives high marks to fundamental science: mathematics is in particularly good shape; physics, not at all bad, though too much is being spent on purchasing equipment in comparison with operating it; not enough is being spent on biology; but on the whole, the health of pure science is good. Applied science, on the other hand, is in terrible shape.

Why? I asked the former head of the *Délégation Générale à la Recherche Scientifique et Technique*, Pierre Aigrain, who was a familiar figure at M.I.T. even before his year as Luce Professor in 1973-74. Because, he said, "there is a lot of unappliable applied science—science not connected with what industry can use." The work is done mostly in government laboratories. The programs may be interesting, he said, but they do not necessarily correspond to the problems of the economy, and so the results are not easily embraced by the industries which are most in need of new technology. French industry spends roughly the same fraction of its own money on research as American industry does. What French industry lacks is government support, says Dr. Aigrain. Only about 35 per cent of the French government's investment in applied research is given to industry.

Elitism as a Napoleonic Legacy

Dr. Aigrain blames Napoleon; the situation is "a natural consequence of Napoleon's administrative system," he told me. "You have a problem, so you set up an agency to solve it. One problem, one organization."

And it is also true that, in general, France has no military-industrial complex—the presence of which would at least indicate, thought Dr. Aigrain, that industry is dynamic. "Those industries in the *secteur de pointe* [which we may translate as glamor industries], such as electronics and aeronautics, are dynamic and doing well technically if not financially. The chemical industry, though older, is also doing well. In other fields, though, companies are smaller. They are old family operations that tend to exploit the one product they have been raised on rather than engage in research."

The overall national scarcity of invention can partially be blamed on Napoleon again. In line with his penchant for "one problem, one agency" he set up the *grandes écoles*, highly specialized schools to service the state. Today, because students at the *écoles* have been so rigorously selected, they are the ones chosen over university students for the better positions in society. Newspaper ads for higher paying jobs constantly specify "*grande école.*" Industrial management comes, not from laboratory scientists, but from one particular school founded to train engineers for the army, the *Ecole Polytechnique*, which is under the Ministry of the Army and has a general at its head.

"A big difference between American and French society is that in the U.S. a man is appreciated for what he does, while in France he is appreciated for what he does before he does anything," is the way Roland Omnes, Professor of Physics at both the Faculty of Sciences at Orsay and the *Ecole Polytechnique*, put it. That can be translated to mean that anyone who gets into a *grande école* with a reasonable ranking is set for life no matter what he does, "provided he's not stupid."

Having taught at Berkeley for two years, Professor Omnes is in a position to compare American students at a major university with his *Ecole Polytechnique* students. At age 19 or 20 his *école* students are better. At age 24 it is the other way around.

One consequence of the rigidity of the French educational system is that a student must decide upon pure or applied research at a rather early stage. In the United States it is only after the Ph.D. that he decides, *and then he can change.* In France, after obtaining the doctorate, scientists stay in fundamental research all their lives. With more and more going into fundamental research and few going out, the result is the weakness of applied research.

Continued on p. 92

Reactor Safety: Almost Without Reasonable Limit, But Catch Us If You Can

Debate over the safety of nuclear reactors will never be the same again. With the release of its latest study, the Atomic Energy Commission has pulled the rug out from under the feet of its most vocal critics.

The $3-million, 14-volume draft report by an engineering team under one of the nation's top reactor safety experts, Norman C. Rasmussen, Professor of Nuclear Engineering at M.I.T., claims to have done just what the Commission's adversaries have often demanded: it sets out in detail the risks and consequences of a host of different accidents at nuclear power plants.

The study concludes that accidents at nuclear plants rank with "acts of God"; "nuclear power plants have achieved a relatively low level of risk compared to many other activities in which our society engages." The consequences of major accidents—fuel melt-downs, steam explosions, loss of cooling water, and so on—even when viewed "on the conservative side of realism" could not be nearly so catastrophic as past A.E.C. reports and Ralph Nader have declared them to be. Professor Rasmussen's team examined a multitude of causes and the positive consequences of many conceivable failures within a reactor system: earthquakes ("62 specific systems and components were examined with regard to seismic design"), tornadoes, floods, aircraft impacts, and turbine failures, as well as events which might result from manufacturing flaws and operating errors. But some significant risks, sabotage and theft of nuclear materials, are not included.

For example, the probability of a major rupture in a pressurized water reactor cooling system (a 6"-diameter hole—the "loss-of-coolant" accident—*see p. 79*) came out to be 1×10^4 per reactor-year. The probability that such an accident would be followed by failure of the emergency core cooling system is 6×10^3 per reactor-year, and the total probability of core melt resulting from a large cooling system rupture is 5×10^6 per reactor-year, or one event in 200,000 reactor-years.

A smaller core cooling system break—2" to 6" diameter hole—has a higher probability—3×10^4 per reactor-year, but its results may not be so serious; the probability of a core melt from this cause is only 9×10^6 per reactor-year. And very small cooling system breaks—½" to 2"—are still more likely: 10^3 per reactor-year, 10 times more likely than the major rupture.

The probabilities of accidents resulting in core melt-downs are even lower in the boiling water reactor, but this is offset by the fact that more radioactivity would be released from a boiling water reactor core.

Putting Numbers on Safety

One of the thorns in the side of the A.E.C. in the safety arena has been the so-called Brookhaven report, which estimated the consequences of a calamity at a relatively small reactor; the conclusion was that 3,400 people might be killed and 43,000 taken acutely ill if the worst happened. But by bringing a new and more sophisticated analysis to bear on the same sized reactor, the A.E.C.'s new study predicts only 92 deaths and 200 acute illnesses.

The Rasmussen study's conclusions have drawn responses ranging from polite to angry expressions of disbelief from avowed nuclear energy critics. Characteristic is the comment of Tom Cochran, a biologist with the Natural Resources Defense Council: "I just can't believe it." How similar this is to the reaction of the nuclear energy advocates just two years ago, when intervenors raising detailed and highly technical safety issues at A.E.C. hearings found nuclear engineers could not prove that reactors were safe. Now it appears that the Atomic Energy Commission has turned the tables and brought its vast resources to bear on the problem of putting numbers to these safety issues.

"When we began, I didn't think it would be possible to come up with any meaningful figures," acknowledges Professor Rasmussen. But after two years of pioneering analytical work, he stands behind the results.

Professor Rasmussen admits that quite a bit of uncertainty remains in many of the numbers his team worked with. But that fact is essentially irrelevant when it comes to weighing the validity of the study's conclusions, he claims. On the one hand, many of the uncertainties are in areas that do not contribute to the overall risk. And the final risk figures for reactors are so much below those of airplane crashes, dam failures, chemical explosions, and other common mishaps that even with an uncertainty of 10 or 100, atomic energy comes out smelling like a rose.

Fault Trees and Event Trees

In order to estimate the chances that a reactor would fail, Professor Rasmussen and his colleagues turned to an esoteric new science called fault tree analysis, developed by the Department of Defense to fail-safe weapons systems. The same analytical method was used in N.A.S.A.'s efforts to prevent further tragedy after the fire that killed three Apollo astronauts.

Previously, this methodology had been used for designing equipment. N.A.S.A., for instance, specified equipment that would fail only once in 10^{15} years. Then manufacturers would attempt to design a system that had such a low failure rate, at least on paper.

But the A.E.C. group was faced with analyzing a system that had already been designed and built. So they were forced to embroider on the traditional fault tree methods.

They called their development an event tree (*see* Technology Review *for March/April, 1974, p. 7*). First, they assumed that a particular piece of equipment would fail. This would lead to physical conditions that might cause another system either to work or to fail. And so on. In this way, accident chains that might lead to releases of radioactivity were determined.

Next, standard fault tree analysis, consisting of determining which parts must fail to render a total system inoperable, was used to estimate the probability of each step in these accident sequences, and from this chain of probabilities the overall probability of such a pathway was calculated. Then, from the physical conditions and the test data on the individual parts, the probability of system failure was estimated.

The final part of the study involved determining the consequences of various types of releases of radioactivity under a number of different meteorological conditions. Unlike past studies, this one used realistic population figures, postulated partial evacuation of the surrounding area, and assumed that a large plume of radioactive gas would rise due to its intrinsic heat.

The A.E.C. let Professor Rasmussen hire just about everyone who is qualified in this type of analysis, he says. These are relatively new and deceptively simple techniques; as a result, despite the expertise which was involved, a number of caveats are sprinkled throughout the re-

port. For instance:

"Any modeling depends upon the skill of the analyst. However, skill is particularly important for fault trees where few explicit rules and guidelines exist."

Professor Rasmussen is also careful to emphasize that these methods should not be viewed by the zealous as a way to supplant present regulatory "common-sense" procedures. For one thing, there are too few people able to perform such in-depth analysis, he says.

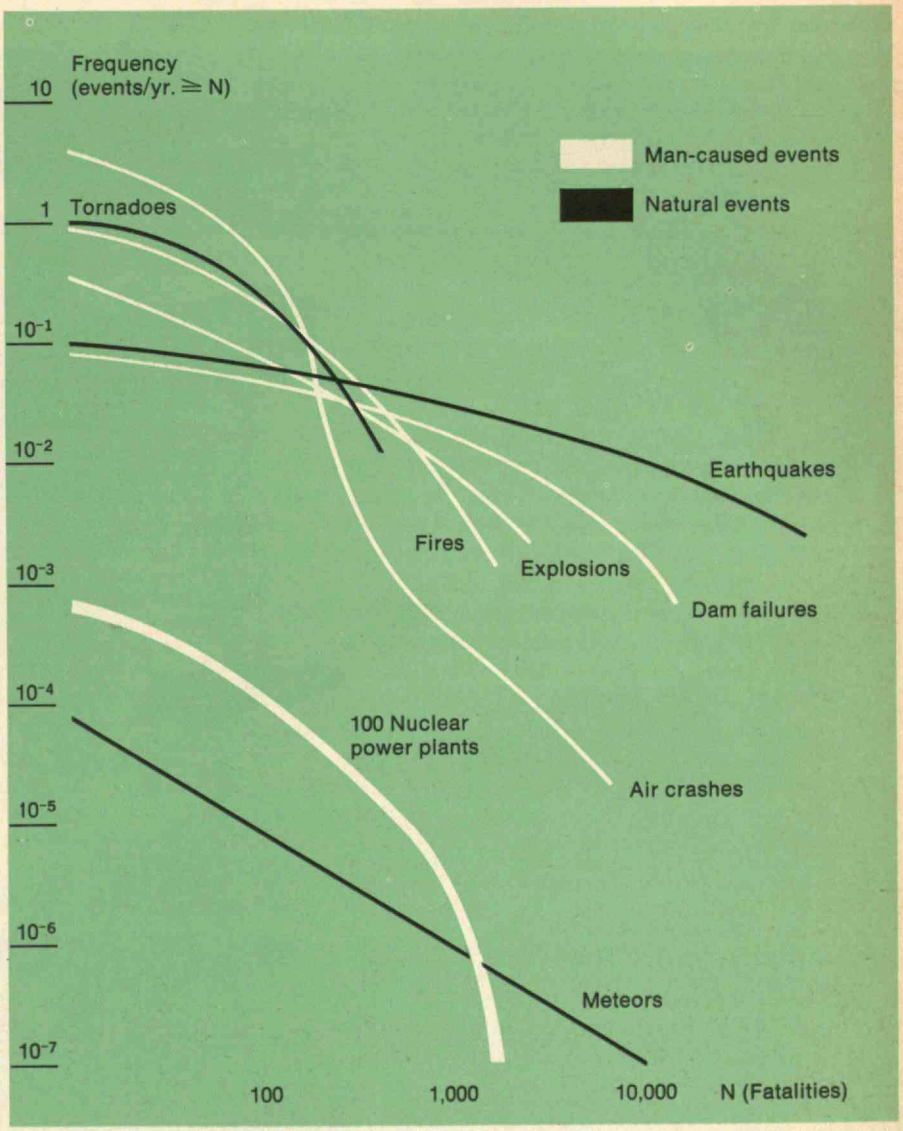
How to Challenge the Innovator

None of this is calculated to make the A.E.C.'s adversaries happy, and they have not in fact been silenced. Professor Rasmussen's caveats can be used to discredit the study. Because much of the spadework was done by A.E.C. and reactor vendor employees, the question of bias arises. For example, Professor Henry Kendall of M.I.T., a leader of the Union of Concerned Scientists (*see p. 79*) told *Science*, "I don't know how anyone could call this an independent report in any sense of the word."

Another problem has to do with the sheer size of the Rasmussen study's 14-volume report and the extent of the resources needed to do an equally extensive analysis to confirm or challenge the conclusions. Such a project would be especially difficult because so few understand the fault tree/event tree techniques or have access to the detailed plant designs and other information on which the techniques are based.

This study clearly represents a pioneering effort to quantify the risks represented by a nuclear reactor—or any other complex engineering system—before one has failed. As such, the results cannot be taken as gospel—Professor Rasmussen agrees. But study may well serve as an objective framework for future discussions of reactor safety issues.

David F. Salisbury has been following the nuclear reactor safety controversy for several years as science writer for The Christian Science Monitor; *his survey of reactor experts' opinions* (see *Technology Review* for March/April, 1974, pp. 6-7) *won for him the $1,000 1974 Science-in-Society Journalism Award of the National Association of Science Writers.*



Even when 100 nuclear reactors are in operation in the U.S., the chances of an individual being killed in a nuclear power plant accident will be about the same as the chances of the same individual being killed by a meteorite—one in three hundred million. (Chart adapted from Reactor Safety Study, *U.S.A.E.C., August, 1974.)*

Though Siberia is proclaimed "a raft on an ocean of oil," a detailed analysis of Soviet documents suggests that the U.S.S.R. has an "energy crisis" fully as threatening as in any Western nation, severe enough to carry significant implications for future international economic and political relationships.

Petroleum deposits in the Tyumen (West Siberian) region are known to be large, and active exploration is under way; this 1973 photograph shows an exploratory expedition credited with locating some 20 deposits in the North Tyumen during the summer of 1973. But conditions in the Ob River valley are difficult—it is a vast marshland inhospitably cold in the winter and wet in the summer—and its oil reserves (their actual size is still unclear) are far from the energy-demand centers of the European U.S.S.R. It is out of such frustrations that is fashioned the Soviets' growing concern for their present and future energy supplies. (Photo: Tass from Sovfoto)

Marianna Slocum

Soviet Energy: An Internal Assessment

The prevalent Western assumption is that the Soviet Union has a large precentage of the world's hydrocarbon fuel resources and that the U.S.S.R. is willing and able to become a major energy exporter to the West. This assumption has been reinforced to a large degree by Soviet exports of oil and gas to the West as well as to Comecon countries, the Eastern European countries which are members of the Council for Mutual Economic Assistance, the riposte to the Organization for European Economic Cooperation (O.E.E.C.). However, an intensive analysis of the Soviet publications reveals that the energy situation in the Soviet Union poses a serious dilemma: In order to sustain planned economic growth, the Soviet Union will have to progressively increase the imports of oil and gas from the Middle East area, will have to import technology, and will have to obtain immense investment credits.

Fuel shortages in the Soviet Union have been in existence for a number of years; however, the problem assumed new dimensions in the 1960s because of an increasing energy demand due to industrialization, an increasing share of oil and gas in the fuel/energy balance, and the depletion of the major fuel reserves in the demand area. Thus the Soviets were forced to commence development of oil and gas resources on a large scale in the remote areas and at the same time to initiate a number of other measures designed to alleviate increasing industrial energy shortages.

A number of fuel/energy conservation measures have been introduced which go considerably beyond the normal exhortation against waste, and a great effort has been put forth to expedite the development of the remote oil and gas reserves and the construction of the requisite pipelines. Because the task is beyond the Soviet means, the U.S.S.R. has been successfully soliciting participation of Comecon countries in the form of credit, technology, materials, and human resources in the development of her remote oil and gas reserves and pipelines, as well as in the expansion of her industry. Yet even with the joint efforts of the Warsaw Pact countries, the Soviet Union has not been able to develop her new resources and at the same time to proceed with her planned economic expansion, most of which—as the extensive Soviet studies indicate—must take place in Siberia. Industrial expansion in the developed regions of the European U.S.S.R. is not economically justified because of shortages of energy, water, and industrial land.

At the same time, the Soviet Union is faced with a number of problems, including:

—Uncertainty about the true size of the Siberian oil and gas reserves.

—Unexpected difficulties and escalating costs encountered in developing remote resources located in regions with harsh environmental conditions.

—Escalating shortfalls of fuel, energy, and raw materials.

—An inability to meet Comecon countries' increasing demands for fuel, energy, and raw materials.

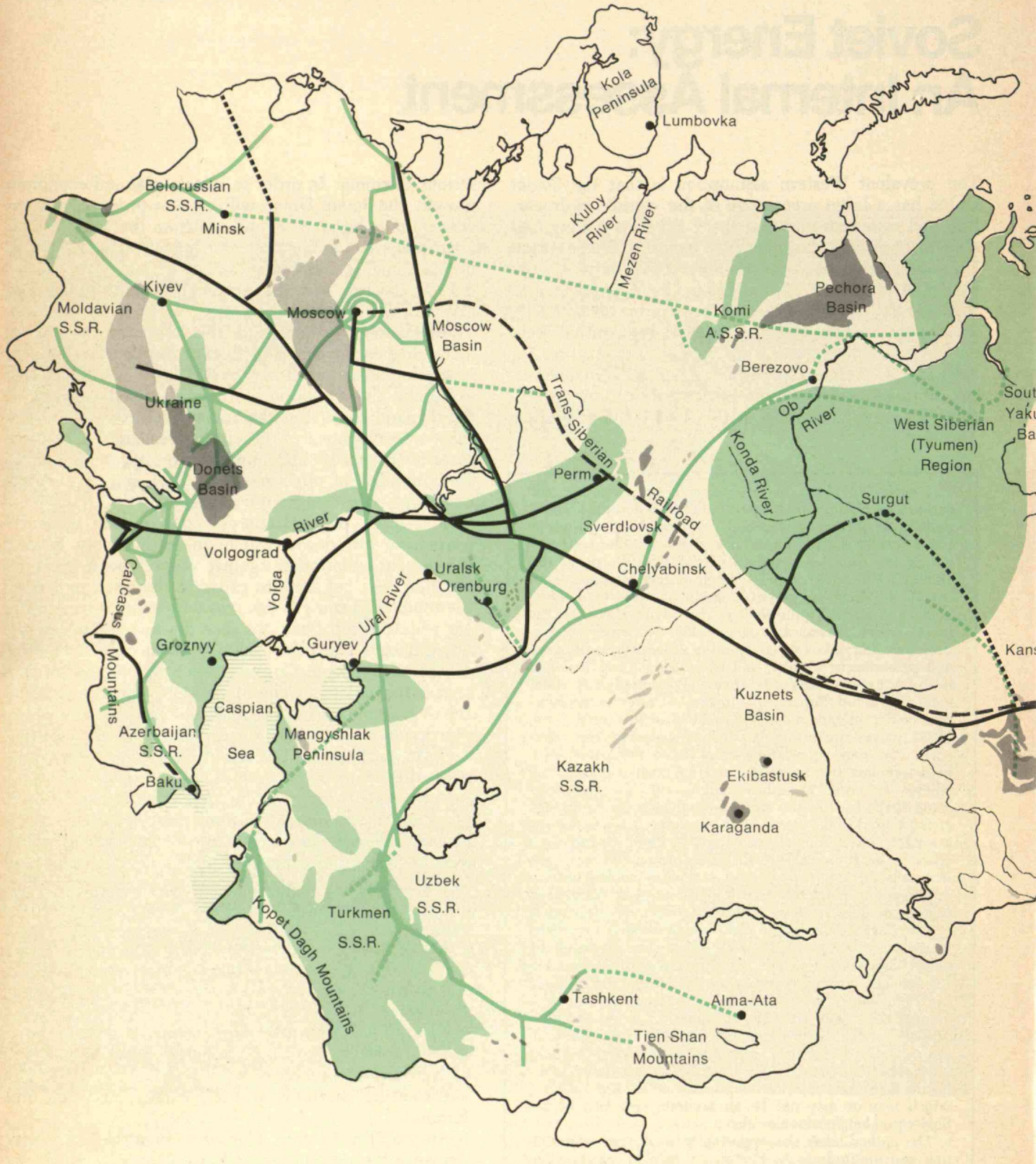
—The need for advanced Western technology and immense investment credits.

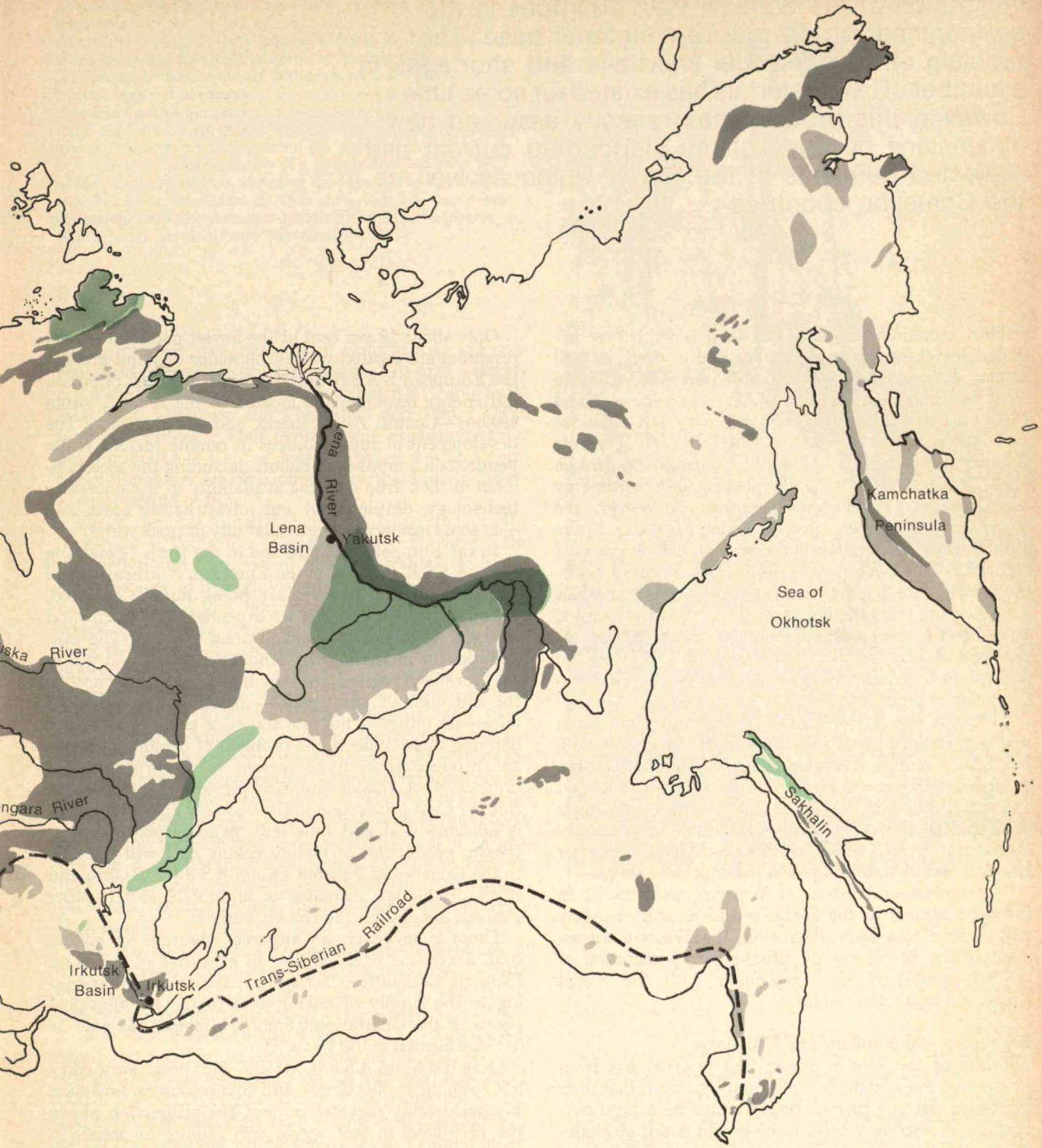
The author's attempt in this article is to present as accurate a picture as possible of the officially accepted Soviet position on energy supplies and development in relation to discussions of the allocations of capital and other resources within the planning structure of the government of the U.S.S.R. The Soviet views of their energy situation were compiled during an extensive study of more than 2,000 books and journals published in the Soviet Union for internal Soviet consumption since 1965. No statement has been included unless it was found in at least three different and authoritative sources; and no statement was included if at any time an indirectly or directly contradictory statement was found. Superscripts in the text refer to the numbers of the references listed at the end of this article (pp. 32-33) where supporting data is found; specific page references and some translations from those references have been supplied by the author and are available from the editors. In order to reduce redundancy, the references listed at the back of this study are only a small percentage of those used in the course of the analysis; however, all the available Soviet sources were cross-checked against each other in order to be sure that the information used was internally and externally consistent in all available sources.

The author notes that Soviet numerical data are used in this paper only as trend indicators, because no complete sets of Soviet data on the fuel/energy balance or related topics are as yet available to the West. The fragments of Soviet data series that are available are usually incompatible with each other. Not only are no descriptions given of the methodology used by the Soviet authors in the compilation of their data, but there is extensive internal evidence that the methodology varies considerably from source to source. Any attempt to develop a series by interpolating or interpreting fragmented data of this sort inevitably introduces approximations, assumptions, or "mirror images" which may or may not be an accurate reflection of the Soviet problem, position or plan.

The author takes this opportunity to express appreciation and gratitude to A. Pietsch for help in selecting appropriate materials, for compiling the bibliography, and for many illuminating discussions.

The sources of the Soviets' energy dilemmas are made obvious by a map such as this, showing fuel/energy resources and major transportation facilities. Many of the raw material deposits shown in the northern and eastern U.S.S.R. cannot be economically developed in the foreseeable future, writes the author; they are in areas where exploration and development are difficult and expensive, and transportation facilities to bring them to the energy-demand centers of western Russia—or even of the Urals and Siberia—are lacking. Meanwhile, fuel/energy resources in European Russia—except for the Komi A.S.S.R., in the northeast—are being rapidly depleted. (Technology Review map by Charles V. Mahlmann)




Lena River
Lena Basin
Yakutsk
Kamchatka Peninsula
Sea of Okhotsk
Sakhalin
Irkutsk Basin
Irkutsk
Trans-Siberian Railroad
Coal basins – proven and probable reserves
Brown coal basins – proven and probable reserves
Oil and gas regions
Offshore oil and gas regions
Oil pipelines in operation
Oil pipelines planned or under construction
Gas pipelines in operation
Gas pipelines planned or under construction

". . . One of the main objectives of the economic integration of the Warsaw Pact countries is the development of the fuel/raw material base. The problem of covering fuel shortfalls and shortages in a number of raw materials has existed for some time. However, this problem has recently assumed new dimensions because of the stepped-up current and projected demands in the Soviet Union as well as in the Comecon countries . . ."[2]

Thus economic necessity has to a large degree affected Soviet foreign energy policy and strategy, as well as her determination for self sufficiency. In order to meet her immediate and escalating domestic demand for fuels (as well as for certain raw materials), the Soviet Union has been making long-term arrangements for increasing imports of oil and gas from the Middle East and has been gradually phasing out her energy commitments to Comecon countries. Moreover, the Soviet Union has been actively seeking assistance in the West for the exploration and development of her own resources, including the possibility of obtaining heavy investment credits from the wealthy Arab nations (negotiations for this, according to British sources, have been in progress). The Soviet Union is also exploring the possibility of shipping Middle Eastern oil and gas to the European continent, via Soviet territory, using Soviet pipelines.

Although the Soviet Union undoubtedly will be a major participant in the international energy market, her future role as a major energy importer, exporter, or broker will depend on a number of factors such as: the size of her own resources (as yet unproved), their development costs, the ability to raise the necessary investment capital, and a possible desire to preserve her resources for obvious long-term strategic advantages.

The success and extent of Western involvement in the development of the Soviet resources and economy will depend to a large degree on the Western assessment of the Soviet energy situation; fragmentation of trading operations and agreements with the Soviet Union will be another factor.

Resources—the Fundamental Unknown

The size of the proven Soviet fuel reserves has been questioned even by the Soviets, on the grounds that their published data on proven reserves include a high percentage of reserves whose development is not economically justifiable in the foreseeable future.[7,15,22,23,24] Noncommercial deposits were included in the officially published data on proven reserves for a number of reasons, such as governmental incentives for the exploration and prospecting in the geologically less promising regions (located in the energy-demand areas), and desire on the part of all concerned to fulfill the planned increment of proven fuel reserves (which was based on the so-called "gross value output"—i.e., the sum total of all new reserves irrespective of their commercial value).[7,15,22]

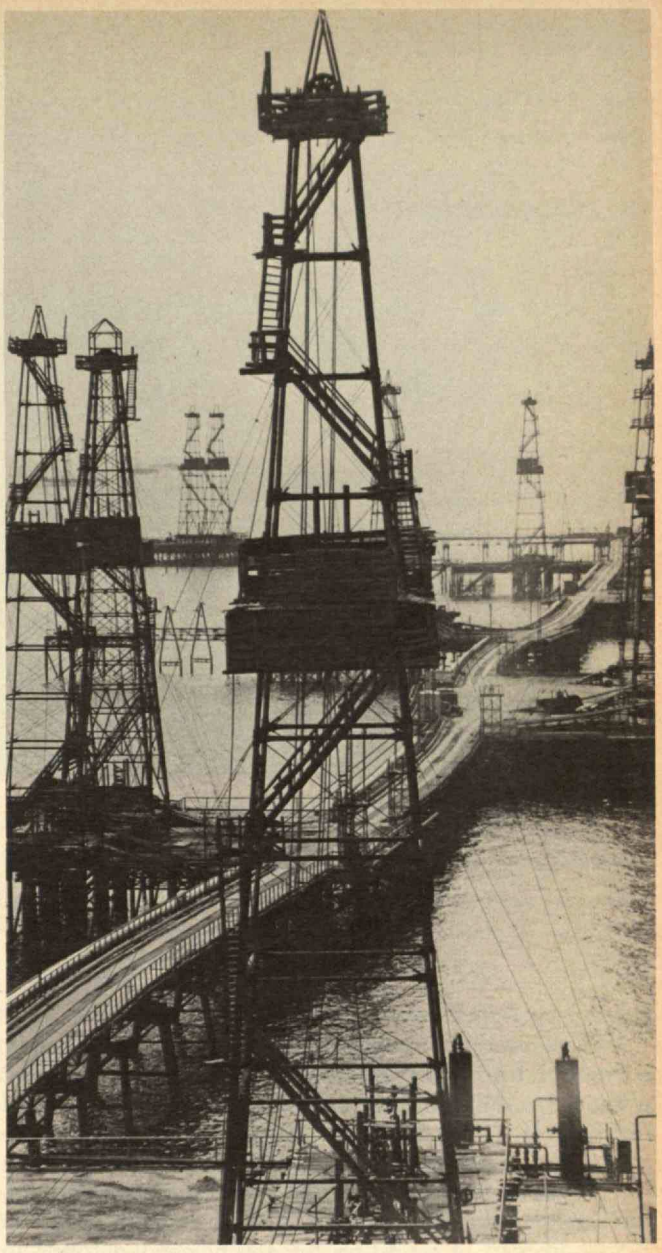
Only about 12 per cent of the Soviet potential energy resources are located within the major demand areas—the European U.S.S.R. and the Urals; the bulk of potential energy resources are located in the remote, virgin regions—Central Asia, Siberia, and the Far East. The development of fuel resources in remote regions is dependent on a number of factors, including the ascertainment of their true size, the availability of the necessary technology, development and infrastructure costs, and —in some instances—the availability of fresh water.

In the European U.S.S.R. and in the Urals (excluding Komi A.S.S.R., located in the European Northeast), fuel and raw material reserves are being rapidly depleted, yet no new major deposits are expected to be discovered in these major energy-demand areas.[9,22,29,30,53] The possibilities for increasing the production of oil and gas in the European regions are very limited, because most of the old oil and gas regions—including the principal ones—are either in the late stages of production or are entering them. Indeed, the problem of declining oil and gas production in these regions is acquiring special urgency.[9,41] A similar situation prevails in the coal industry: Coal production in the Moscow and Ural basins is uneconomical and thus will, in all probability, decrease; production of mainly coking coal will increase in the Donets and Pechora (Komi A.S.S.R.) Basins; and small production increases of anthracite and cheaper coal are forecast for the Donets Basin.[29]

There is however, an apparent shortage of coking coal. According to G. Mirlin, an executive of the State Planning Committee, "A tense situation persists pertaining to the supply of coking coal to the metallurgical plants in the Central and Southern regions, as well as to those located in the Urals."[24]

Only the Komi A.S.S.R. (in the European Northeast) has large probable oil, gas, and coal resources; however, to considerably increase oil and gas production above the 1970 level in that region will require an intensive effort to close the 20-fold gap between probable and proven reserves.[25] In addition, the problems of exploitation will be severe: These resources are located in the permafrost area (Timano-Pechora regions).[25]

Central Asia's proven gas reserves include twice as many noncommercial deposits as do other gas-bearing regions in the U.S.S.R.; in addition, the gas from a number of commercial (but yet undeveloped) gas reserves shows a high content of hydrogen sulfide. Many Central Asian gas reservoirs are deep, and a number are located in remote, arid, seismic regions.[22] Indeed, the poten-



By the end of World War II, the famous Russian oil fields surrounding the Caspian Sea were being depleted, and Baku lost its place as the major source of Soviet oil. Now most other oil and gas deposits in the European U.S.S.R. are becoming uneconomic; the Soviet Oil Minister V. Shashin writes, ". . . presently most of the old petroleum regions are either in the late stages of development or are entering them. This is a time when petroleum extraction decreases or becomes stabilized for a certain period. The problem is acquiring special urgency since we are talking about the 'aging' of not just a few individual fields but rather of a large quantity of them in whole petroleum regions, including the principal ones in the country's European section."[41] Thus the Soviets find themselves increasingly dependent on new-found resources in the inaccessible Siberian north. (Photo: Tass from Sovfoto)

tial (probable) gas resources of Central Asia are concentrated primarily within the limits of its arid, scarcely populated Western desert in the Uzbek S.S.R. and Turkmen S.S.R., between the Tien Shan and Kopet Dagh mountain ranges.[22] Thus considerable expansion of the gas production in Central Asia is interfaced with a number of difficulties which cannot be resolved in a relatively short period of time.[22]

Large deposits of oil have been discovered on the Mangyshlak Peninsula (Caspian Sea). However, the production and transport of this Mangyshlak oil is difficult because of its high viscosity due to unusually high paraffin content and because of the scarcity of fresh water in the area. Indeed, the Mangyshlak oil is so thick that pipelines carrying it must be heated to keep the oil from solidifying. The area is a desert; nuclear-powered desalination plants have not been able to supply enough fresh water for industrial and other needs. It is questionable whether the recently discovered ground waters will be large enough to sustain the desired production expansion, and whether a successful and economical method can be developed for preventing underground salt waters from seeping into new fresh water wells. Thus the desired expansion of oil production on the Mangyshlak Peninsula will be increasingly costly and may raise the production (and transportation) cost of Mangyshlak oil to a prohibitively high level.[22]

The Soviet press has given glowing descriptions of West Siberian (Tyumen) oil and gas resources: "Greatest discovery of the century. . . . Siberian oil and gas resources are comparable to—or even bigger than—those in the Middle East-Persian Gulf area. . . . Siberia is a giant raft floating on a vast ocean of oil and gas. . . . Eventual annual oil production [in Tyumen] may reach 500 or even 1,000 million tons. . . ." Although the Soviets did publish several numerical estimates of their West Siberian gas reserves, the official data on Tyumen oil reserves have in fact never been released.

It is known that many of the Tyumen oil reservoirs are large, and a number of them have two or three productive horizons. Most wells produce between 50 and 100 tons of oil daily, and some yield 1,000 tons.[51] Tyumen oil fields are located in the West Siberian plain, in the flood plain of the Ob River, and also in Siberian swamplands near the town of Surgut.[46] The entire Tyumen region is known for its harsh climate—deep frost and snow and violent storms. There is extensive flooding from spring until August[47,57] on all streams, and the Ob River valley is usually flooded from the end of May until August. The flood plain has many treacherous quagmires: Much of the area is either swamp (60 per cent of the West Siberian plain is swamp[57]) or dense coniferous forest; there are also unmerciful armies of mosquitoes and the fetid taiga air to deal with.[51]

A number of Tyumen gas fields are located in the downstream part of the north-flowing Ob River, and the principal ones are north of the Arctic Circle, in regions which are remote and inaccessible, where engineers confront blizzards, polar nights, and solid permafrost, some of it covering bogs and marshes which become sinkholes when the frozen surface is softened.

In view of the inconsistencies between the Soviet claims of almost unlimited Siberian oil and gas resources and the Soviet eagerness to sell their oil and gas to the Western countries on one hand, and the Soviet energy policy on the other, it seems appropriate to raise the following questions:

1. If indeed Siberia is floating on an ocean of oil and

	Economical hydropower resources		Technically feasible hydropower resources		Potential hydropower resources		Per cent utilization of hydropower resources		
	Billion k.w.h.	Per cent of total	Billion k.w.h.	Per cent of total	Billion k.w.h.	Per cent of total	1965	1970	Projected 1980-85
European U.S.S.R.	192	17.5	298	14.0	562	16.7	8.5	10.4	16.7
West Siberia and Central Asia	†		†		†		†	†	†
East Siberia	350	32.0	664	31.5	848	25.0	2.16	4.7	12.5
Far East	294	26.9	684	32.5	1,009	33.0	0.0	0.08	0.7
Total for U.S.S.R.	**1,095**	**100.0**	**2,106**	**100.0**	**3,338**	**100.0**	2.4	3.4	7.8

† No estimates provided.

Soviet potential hydropower resources are huge, yet only a fraction of these can be developed in the foreseeable future.[35] Remoteness, technical and economic problems, and—in many instances—arctic climate preclude the development of most potential hydropower resources.

gas:

Why have the Soviets expressed concern about their current and projected oil allocations, and made a point of the advisability of levelling off gas production around the turn of the century and conserving gas for chemical needs at that time?[15,29]

Why have the Soviets ordered a complete overhaul, including the re-equipment, of their coal industry in 1968[7]—instead of investing the sorely needed funds in the expansion of the Siberian oil and gas production, particularly in view of the highly competitive projected price for Siberian oil and gas in the European U.S.S.R. regions?

2. If indeed Siberia has huge probable resources of oil and gas:

Why have the Soviets stepped up expensive oil and gas exploration in the European regions, where the probability of discovering major oil and gas deposits is quite low?[24]

Why are the Soviets expanding the exploration and prospecting for oil and gas in the offshore regions of their seas and oceans, including the offshore regions of their more frigid waters?[18]

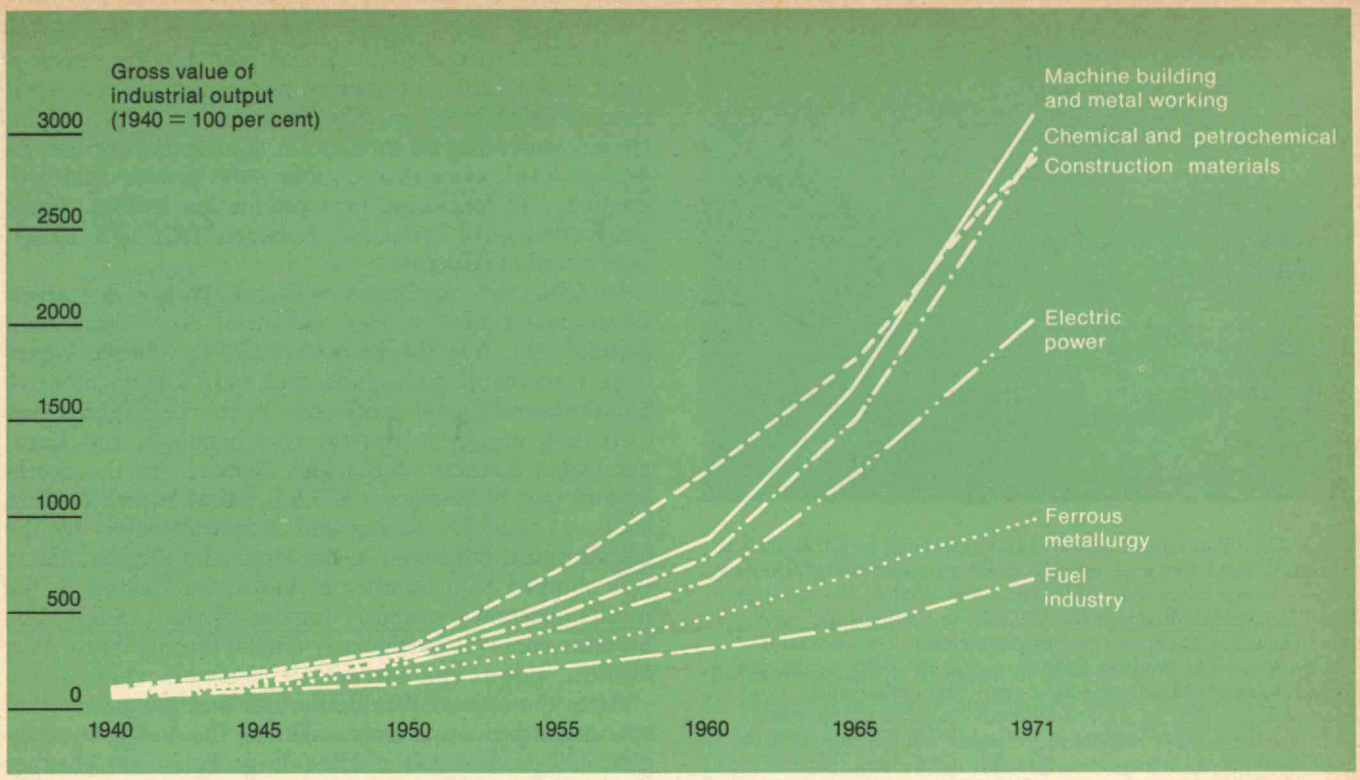
Why are the Soviets scattering their scarce funds and technical personnel instead of concentrating on the exploration of the promising Siberian oil and gas regions? Oil prospecting is presently underway in East Siberia, which contains far less abundant oil resources than West Siberia (Tyumen).[51]

Why have the Soviets been diverting a large number of technical personnel and substantial investment funds to underdeveloped nations for the purpose of prospecting for and developing the fossil fuel (and certain other raw material) resources, particularly in the neighboring countries?[40]

Were the Soviet actions taken because they suspected that Siberian oil and gas resources are not as huge as originally claimed, or because their development is too complex and prohibitively costly? Or perhaps the Soviets simply seek to preserve their fossil fuel resources for obvious strategic advantages and implications in the coming decades?

Vast coal resources are heavily concentrated in the generally remote and inhospitable environments in Siberia. Even though much of the Siberian coal can be strip mined, massive shipments of coal to the European U.S.S.R. demand area will require the construction of additional transportation systems because the existing railroad is already congested.

While huge potential hydroelectric power resources exist in the Soviet Union, only a fraction of these can be utilized for the following reasons: Approximately 18 per cent of the economically developable hydropower resources are located in the European U.S.S.R., the largest of which have been already developed. Further development of the hydropower resources in the European U.S.S.R. is limited by the lack of technology for harnessing average- and small-size rivers with irregular flow.[35] A number of new huge hydroelectric power plants can be built in Siberia. However, many of these would be located near the Arctic Circle, in the downstream parts of rivers that flow north.[35] Technical difficulties and expenses involved in the construction of the necessary systems (including the long-dis-



Despite the concerted Soviet efforts to increase fuel production, the growth of gross value ouput of this sector has been lagging behind that of the energy-intensive industries.[33] For example, the gross value output of the fuel industry in 1968 was 5.7 times that of 1940, while the comparable increase for ferrous metallurgy was 8.5-fold, for electric power 16-fold, for construction materials industry 23-fold, and for machine building 30-fold. In 1968, the fuel industry's output increased 4 per cent; ferrous and nonferrous metallurgy 7 per cent, electric power 10 per cent, machine building and metal working, chemical, and petrochemical 12 per cent. The result is a fuel deficit in a number of regions in the U.S.S.R., and the possibility of an extended fuel deficit is not excluded by the Soviets.

tance electric power transmission lines to the energy-demand centers) will, in all probability, make the utilization of these resources rather unattractive for a number of years.[35] The potentially promising hydropower resources in Siberia are the Yenisey and Angara rivers, whose headwaters are already utilized for hydroelectric power. The southern reaches of these rivers are nearest to large (Siberian) energy-demand centers and offer as well the possibility of developing energy-intensive industries based on the possible abundance in the same area of certain raw materials.[35]

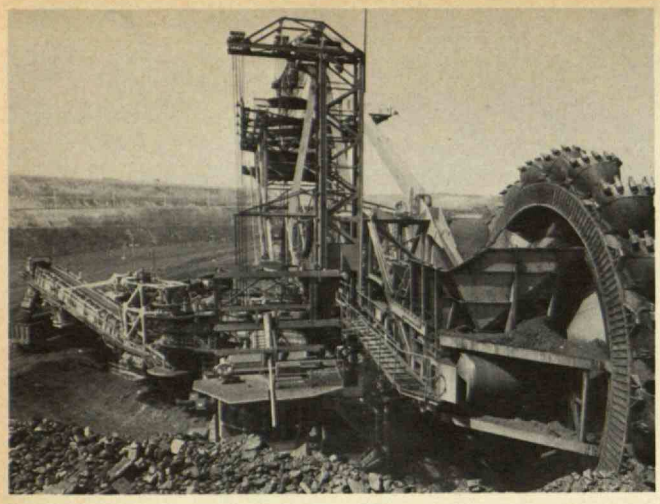
The Soviets are exploring the harnessing of geothermal and tidal power; these resources appear to be abundant in the Soviet Union. An experimental binary-system geothermal power plant was built in Kamchatka, and an experimental tidal power plant (0.5 Mw) in the Kola Peninsula (Kislaya Guba). A number of commercial-sized tidal power plants are planned, including Lumbovskaya (350 Mw.), along the shores of Kola Peninsula, and Kulovskaya (500 Mw.), and Mezenskaya (1,300 Mw.), in the estuaries of the namesake rivers.[14]

The availability of fresh water will be an important factor in the rate of economic growth of various regions in the Soviet Union, and in the distribution of energy-intensive industries.[23] While the Soviet Union has huge fresh water resources, most of these are not located in the demand area; approximately 30 per cent of the fresh water resources are located in the European U.S.S.R. and the Urals, with the density decreasing from North to South. Fresh water resources are particularly problematic in the Kazakhstan and Central Asia, where they are, for the most part, concentrated in mountainous regions. Here rivers disappear when they reach the flat lands and irrigation facilities must be lined with concrete, and, where possible, shaded. A number of the deserts and semi-deserts of these regions have no surface waters; and in some cases, underground waters are also absent.[24,58] Fresh water shortages are already felt in a number of industrialized, densely populated regions, including the European Center, Donets, North Caucasus, Volga-Ural, and Kazakh S.S.R., (Central Asia).[15] In these regions water shortages are likely to be more severe in the future.[15,23]

Large uranium resources exist in Siberia. However, wide use of nuclear power will apparently not constitute an economic solution to the energy problem in the European U.S.S.R. in the near future. This is because, in the present state of the art, electricity generated by nuclear power plants cannot compete in cost with that from conventional fossil-fueled plants.[30] By 1982, the Soviets plan to increase the nation's nuclear power capacity to about 30,000 Mw., or about 18 per cent of the total 1970 power capacity.[35] The achievement of that goal, however, will depend on expansion of the requisite design, testing, experimental, and manufacturing facilities.[35]

Development of the Soviet Fuel Industry

The Soviet government has recognized the importance of energy for the industrialization of the nation, and the development of energy sources has been emphasized ever since the Communist government came to power. This emphasis on achieving high energy production



Some 37 million tons of coal will be strip-mined in Kazakh S.S.R. (Central Asia) this year, enough to fill a train of 620,000 railway cars—"a train more than 9,000 km. long—that is, the distance from Leningrad all across the U.S.S.R. to Vladivostok," says the official Soviet caption to this photograph. The excavator shown is said to produce 3,000 tons/hr. By 1975 production here is to reach 56 million tons a year. The author notes, however, that the existing (Trans-Siberian) railroad is congested and that the massive shipments proposed will require construction of additional transportation facilities.[35] (Photo: Novosti from Sovfoto)

goals set by Soviet energy policy-makers was particularly evident on two occasions: after World War I and after World War II. In each case the development of new energy sources was given priority, despite the fact that a great effort was desperately needed to rebuild housing, industries, and the economic base after great physical wartime destruction.

Understanding the history of Soviet energy policy and developmental programs is helpful to those who would analyze the Soviet Union's energy situation today. For the present purposes, that history can begin in 1913, when coal and oil were being produced in European Russia on an industrial scale—coal in the Donets region and oil in the Caspian sea region (Baku and Groznyy areas). To meet industrial and transportation needs, Donets coal and Baku fuel oil were often transported over great distances. While some petroleum and petroleum products were exported, a significant quantity of coal was imported. For example, in 1913 Russia imported—primarily from England—9 million tons of coal and coke (about 30 per cent of domestic coal production), while at the same time 1 million tons of petroleum products were exported, out of a domestic production of 9.2 million tons of oil.[33,52]

After the revolution the production of coal and oil declined drastically: coal to 30 per cent (in 1920) of its prewar level and oil to 42 per cent. There resulted a fuel shortage which was particularly acute in the central regions of the country which were cut off from Donets coal and Caucasian oil; in 1919 Lenin wrote that fuel shortages were so serious as to threaten catastrophe. For years, firewood became the main form of fuel—used not only by the population in general, but by the industrial and transportation sectors as well.[21,33,52]

It was at this time that the new government began serious plans for the development of future energy supplies.[33]

In 1920 the State Electrification Committee (GOELRO) prepared a 15-year plan for the development of the national economy on the basis of a national electrification program. The goals set by GOELRO included increasing oil production to at least 1.5 times its prewar level, more than doubling the prewar coal production, and increasing peat production tenfold. These production goals were met between 1931 and 1934,[33] well ahead of schedule.

In 1930, in compliance with the Party's directives, development of a second industrial coal basin commenced; this was the Kuznets Basin in Siberia, where huge reserves of high-grade coal were known to exist. Simultaneously, coal production in the Ural region was increased, and development was begun in the Karaganda (in Kazakh S.S.R.) and Pechora (in the northeastern part of European U.S.S.R.) coal basins. Eastern coal was used for coking and industrial needs by the metallurgical industries in the Urals and Siberia, and it was shipped to a number of industries located in the most important (western) regions of the U.S.S.R. The Siberian coal was particularly crucial during World War II.[33]

After the second World War, oil and gas production was organized on a large scale in the Volga-Ural region. Oil produced from these large fields was cheaper than Baku oil, where many deposits were already being depleted, and Baku soon lost its place as the major source of Soviet oil.[33] A considerable increase in gas production during the 1955-65 period was made possible by the development of large deposits in the Northern Caucasus, Volga region, and Ukraine.

As the oil and gas production in these regions has begun to peak out, the development of new deposits in remote regions with unfavorable terrain and climatic conditions has begun. For example, domestic gas production increased during the 1966-70 period primarily because of newly developed deposits in Central Asia and Komi A.S.S.R.[53]

Extensive geological surveys and exploratory operations for oil and gas had begun in 1934 in West Siberia (Tyumen); the first experiences (1934-43) showed that exploration was exceedingly difficult and complex and that a concerted effort would be necessary to extend these explorations and geological surveys. Nevertheless, the search for Siberian oil was resumed in 1946,[4] and the first commercial-sized yield from the first natural gas well in Berezovo (Tyumen region) was recorded in September, 1953.[4] Financial support for exploration was considerably increased thereafter, but it was not until June, 1960, that the Soviets made a major oil strike along the shores of the Konda River.[4]

Extensive development of the West Siberian (Tyumen) oil and gas resources was finally approved in 1964,[7] after an extended on-location "analysis and evaluation of Siberian oil and gas resources" by a special commission headed by N. K. Baybakov (the Minister of Petroleum at that time, presently Chairman of the all-powerful U.S.S.R. State Planning Committee). The difficulties involved were suggested in Baybakov's words: Financing the development of Siberian oil resources would be a "hard nut to crack. . . . But we must do it."[4]

Energy Supply and Demand

The demand for fuel and energy in the Soviet Union has been greater than the available supply for a num-

	Unit capital expenditures	Cost	Full cost
Coal: Ekibastuzsk	8.9	1.3	2.7
Coal: Kansko-Achinsk	6.2	1.0	1.8
Gas: Tyumen	10.0	0.9	2.2
Gas: Central Asia	25.0	1.3	5.4
Oil: Tyumen	24.8	2.4	6.2
Oil: Mangyshlak	31.7	3.1	8.3
Coal: Kuznets (strip mines)	19.2	3.8	6.6
Coal: Minusins	19.7	4.7	7.7
Coal: Kuznets (shaft mines)	30.8	6.8	11.5
Coal: Karaganda	30.5	7.6	12.3
Coal: Donets	47.5	8.1	15.3
Coal: Pechora	35.3	7.8	13.1
Estonian shale	25.8	7.7	11.6
Peat	39.7	6.7	11.6
Coal: Moskow basin	62.7	13.8	23.0
Coal: Kizelovsk	48.3	12.0	18.5
Coal: Lengerovsk	47.0	16.4	23.4
Coal: Kirgiziya	53.5	13.0	21.1

Capital requirements for the production of fuels in the U.S.S.R. vary widely,[29] and it is not clear that published figures reflect the full costs. The data are given in rubles/ton (standard fuel equivalent).

ber of years. However, the fuel/energy supply problem is becoming more complex and acute because of rapidly increasing demand and shrinking local supplies in the industrialized regions, the difficulties and high cost of developing fuel resources and transportation systems in remote regions, and the uncertainty about the size of potential fuel supplies from these remote regions.

Soviet demand for fuel and energy has been increasing rapidly because of the rapid development of Soviet industrial and transportation sectors, the increasing mechanization of the agricultural sector, and the effort to replace industrial and communal use of firewood[20,31] by more efficient fuels.[33] A large sector of the population—particularly in rural communities and average and small-size cities—as well as certain industries are still using firewood for heating purposes.[20,29,31] Some of this firewood consumption is not reflected in official Soviet energy statistics compiled by the Central Statistical Bureau, and it is completely excluded from United Nations data of Soviet fuel/energy consumption. For example, the 1967 U.N. data excluded the so-called non-commercial fuels—firewood, peat, etc.—yet these fuels constituted approximately 5.8 per cent of the total Soviet energy consumption in that year.[20,31,37]

In spite of the rapid development of the Soviet fuel industry, the rate of growth of its output has been consistently behind the rate of growth of the major energy-intensive industries.[15,33] A number of Soviet regions have been experiencing fuel/energy shortages.[22,25,31,33] These have been especially acute in some major industrial centers, threatening the disruption of the Soviet economy. In the summer of 1973, for example, serious fuel shortages were reported in such major industrial regions as Sverdlovsk, Chelyabinsk, and Perm.[39] Moreover, the Soviets can give no assurance that the fuel/energy shortages will not persist in the coming years.[20,22,29,33]

One of the major Soviet problems is the supply of fuel/energy to the European U.S.S.R. and the Urals[29,35] —the nation's most densely populated and industrialized areas[22]—which account for more than 75 per cent of the Soviet domestic fuel consumption[20,29] and whose local energy supplies have not been adequate to meet the demand for a number of years—at least since 1965. In these areas are concentrated more than 80 per cent of Soviet industry and approximately 75 per cent of the population,[30] yet only 12 per cent of Soviet potential energy resources are located there.[35] The energy demand in these regions—as well as the energy shortfall—is expected to continue to grow at a rapid rate.[29,35] The energy supply problem in these regions is exacerbated by the rapid depletion of their local fuel resources,[22] by the problems encountered by the Soviets in developing new fuel resources in remote regions under harsh climatic conditions, and by the expenses and problems involved in transporting the fuel over great distances to these major energy consuming markets.[29] One Soviet estimate indicated that the 1970 energy deficit in these regions was approximately 15 per cent of the U.S.S.R.'s 1970 fuel consumption and that the deficit will probably increase five or sixfold in the future (year unspecified).[22] Another estimate points out the doubling of the fuel deficit every five years since 1965 and projects the 1975 deficit in the neighborhood of 350 million (standard fuel equivalent) tons.[29]

Even though the most economical way to cover the fuel deficit in the European regions would be by increased use—in these regions—of gas,[22] such an alternative is highly improbable. According to Soviet energy experts, the energy shortfall in the European regions cannot be covered by any single type of Soviet fuel or energy, for ". . . if the deficit were to be covered exclusively by Tyumen gas, then in the course of the next few years, an annual delivery of 350 billion $m.^3$ of gas (or 175 per cent of 1970 Soviet gas production) to the European regions would be needed, requiring the construction of either 14 gas pipelines of 140 cm. diameter, or five or six pipelines of 250 cm. diameter, each spanning a distance of 3,000 to 4,000 km., which is rather unrealistic. . . ."[35]

The economic desirability of using domestic gas instead of expensive Donets and Pechora coal in certain European regions presents an equally improbable scenario: The production of Tyumen gas is severely limited by the difficulties encountered in developing new deposits in Arctic regions in a relatively short

"The solution of the fuel/energy problem necessitates the development of a teamwork program in underdeveloped countries, aiming at coordinated assistance in their industrialization and at increasing fuel and raw material imports from these countries . . ."[17]

time span. In addition, because of technical complications[22,26] and a lack of pipes,[22] the construction of the northern gas pipeline, which was intended to carry gas supplies to the energy-deficient European area, has been delayed. New gas production from the Komi fields has so far compensated only for the decreasing gas output in other parts of the European U.S.S.R., while the increased deliveries of Central Asian gas to the European U.S.S.R. in the past few years have been possible mainly because large quantities of gas have been imported to Central Asia from Afghanistan.[22] A substantial increase in the production of Central Asian and Komi gas—after 1970—will depend on the solution of a number of problems, including the verification of large probable gas resources in these regions and overcoming their development difficulties.[22]

The replacement of coal by imported gas has been taking place. Imported Afghan gas has been used in lieu of coal in Central Asia,[22] and in the Transcaucasus region, where an expected fuel deficit will be covered not by shipments of domestic coal to that region but by increasing imports of Iranian gas—reaching 11 million (standard fuel equivalent) tons yearly by 1976.[35]

The situation with respect to oil is not very different. The possibility of piping crude oil from the Siberian (Tyumen) fields to the Western U.S.S.R. is rather limited because much of the Tyumen oil will be used in Siberia, Kazakh S.S.R., and the Far East.[29] In fact, oil from the Volga-Ural region is still brought to Siberia—at a decreasing rate, however.[47] Only in the future, if Tyumen oil fields can be made to yield as much as 200 million tons annually—approximately twice the production projected for 1975—will there be a surplus of Siberian oil large enough to be shipped to the European U.S.S.R. and the Urals.[47] Yet in view of the rapidly increasing energy demand in Siberia and the innumerable difficulties encountered by the Soviets in developing fuel resources in virtually virgin lands under inhospitable environmental conditions, the question naturally arises: When, if at all, will a surplus of Siberian fuel be available for delivery to the energy-hungry areas?

	Estimated 1973 cost in the 1971-75 five-year plan (millions of rubles)	Adjusted cost estimate for 1973 plan (millions of rubles)
Ust-Ilimsk hydroelectric plant	690.3	1,025.0
Oil pipeline: Ust-Balyk-Kurgan-Ufa-Almetyevsk	520.0	649.9
Oil pipeline: Kuybyshev-Tikhoretskaya	143.5	267.0
Abakansk railroad car plant	293.0	500.9

Cost overruns plague Soviet planners.[12] Serious concern has been raised about the uncertainty of development costs in the remote, virgin areas.

The possibility of increased large scale deliveries of eastern coal to the European regions in the near future is questionable because of the time required for the development or improvement of coal production and transportation facilities. Moreover, the large capital investment and high cost of eastern coal in the demand centers make this option economically unattractive.

Such other energy sources as hydroelectric and nuclear are not an effective response to an immediate energy crisis; the time and cost for their development are both high.

In the meantime, the current concern for acute energy shortages in the industrial centers indicates that even the imports of Middle East oil and gas have not been able to alleviate the tense energy situation which has existed for some time in the Soviet Union. Thus the immediate problem of supplying the rapidly escalating energy needs of the European U.S.S.R. and the Urals is becoming more complex and critical.

Fuel/Energy Conservation and Stockpiling

The Soviet Union has been adopting increasingly stringent energy conservation measures which go considerably beyond the normal exhortation against waste. A few representative fuel/energy conservation and stockpiling measures ordered by the Soviet Government are outlined below.

In 1964, the U.S.S.R. Council of Ministers issued an official decree relative to fuel/energy conservation measures in the light of the ". . . tense situation in the U.S.S.R. regarding the fuel/energy balance."[7]

The 23rd Party Congress directives outlined the reduction of fuel consumption over the five-year period (1966-70): Industry was to cut down fuel consumption by at least 8 to 10 per cent, and the electric power utilities by at least 11 to 14 per cent.[33]

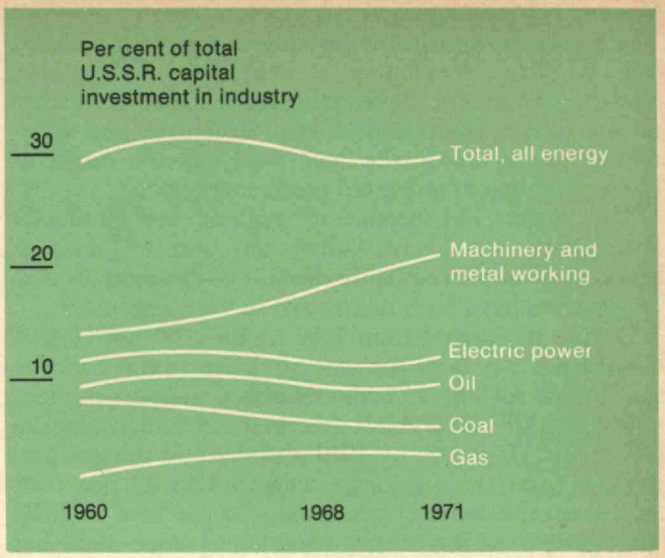
On May 31, 1969, the Soviet newspaper *Izvestiya*

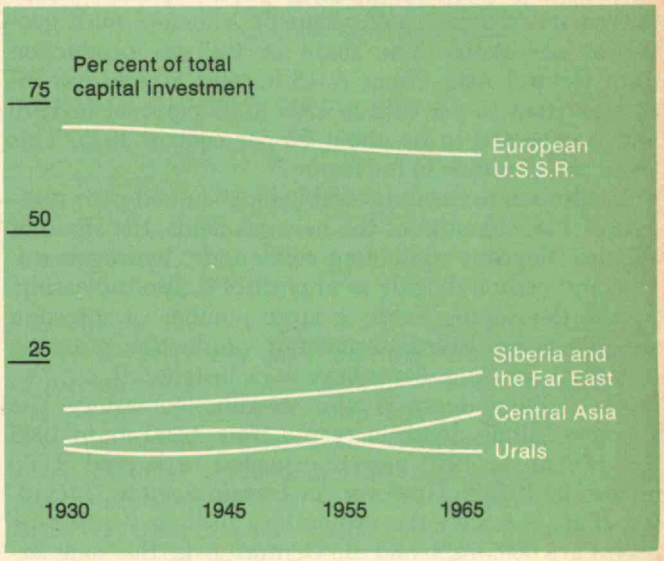
(p. 2) published the U.S.S.R. Council of Ministers' decree concerning the assured supply—on a national scale—of coal, oil, gas, and electric power during the fall-winter 1969-70 period. Emphasizing the exceptional importance of timely preparation for the winter period, the decree directed U.S.S.R. Ministries to assure the establishment of stockpiles of the required quantities of coal, gas, and fuel oil at electric power plants, industries, railroads, and steamship facilities. Strict fuel/energy economy measures were also outlined, including efforts to cut fuel losses, broader utilization of secondary energy sources, elimination of heat losses, and improvement of fuel storage and transportation techniques and facilities. Additional capital investment was allocated for the development of coal, oil, and gas industries. Measures were outlined for increasing decentralization of local fuel stockpiles. The U.S.S.R. National Control Committee was instructed to initiate measures for strict supervision of the imposed economies in electric and thermal energy, fuel, and petroleum products as well as of the stockpiling practices outlined in the decree.

On November 3, 1969, the U.S.S.R. Council of Ministers issued a decree on "Regulation of fuel consumption rates, consumption of electric and thermal energy in the national economy, and incentives for conservation. . . ." Ministries were instructed to review the existing fuel/energy consumption rates for their subordinate enterprises and then to bring these into line with the consumption rates set by the U.S.S.R. State Planning Committee. New consumption rates were to be introduced on January 1, 1970. The decree also outlined economic incentives for fuel/energy conservation, as well as penalties for the use of fuel/energy over and above the specified quantities.[7]

The 24th Party Directives also called for the reduction of fuel/energy consumption by 7 to 10 per cent during the 1971-75 period.[18]

On April 8, 1970, the U.S.S.R. Council of Ministers issued a decree in which emphasis was placed on the economic and efficient use of natural gas. A special Gas Commission was ordered to initiate close supervision of gas consumption, to advise enterprises on the limitations of the gas supply, and to order enterprises to switch to other types of fuel whenever necessary to maintain an uninterrupted gas supply to the population. The Commission was also given power to cut off gas supplies to those enterprises which did not comply with the rules outlining the efficient use of gas.[7]





Top chart: Capital investment in the fuel/energy sector (includes the construction of electric power plants and electric and thermal network systems) has been about 30 per cent of the total capital investment in the industry since 1960.[52] In addition, sizeable investments have been made in such fuel/energy supportive industries as machine building (which produce equipment necessary for the fuel/energy sector), geological exploration and developmental operations, etc.

Bottom chart: The focus of new capital investment in the U.S.S.R. has been gradually moving eastward from the European U.S.S.R. into Siberia, the Far East, and Central Asia.[22] This movement was in partial response to growing shortages of fuel and energy, raw materials, land, and water in the developed areas. Yet the forced and accelerated development of the Asian regions is greatly hindered by the inadequacy of the local construction industries and shortages of local construction materials and labor.

Gas and Oil Production

The Soviet oil and gas industry is faced with a three-fold problem: developing new fields in unfavorable climatic conditions; developing an increasing number of reservoirs in complex geological structures; and maintaining production in the final, most difficult, stages of the exploitation of major old producing regions.

The major old producing regions are gradually losing their significance—their gas and oil reserves are steadily and irrevocably declining—because no new big reserves have been discovered in these regions.[53]

During the period from 1960 to 1965, 80 per cent of the U.S.S.R.'s natural gas was produced in the Ukraine, the Volga region, and the North Caucasus—regions with generally favorable environmental and geological conditions. However, by 1970, the share of the gas production from these regions decreased to 62 per cent, and it is expected to be less than 50 per cent in 1975. The growth of Soviet gas production since 1965 has been due to the development of new deposits located in remote regions with difficult climatic and geological conditions. The share of the gas production from Central Asia, Komi A.S.S.R., and Siberia has increased from 15 per cent in 1965 to 35 per cent in 1970 and is expected to be about 52 per cent in 1975. This trend will continue in the future.[53]

In addition to the unfavorable location and poor geological characteristics of the new gas fields, the share of the new deposits containing condensate, hydrogen sulfide, and carbon dioxide as impurities is also increasing. At the developing fields, a large number of injection wells must be drilled to maintain production pressure, and gas processing plants have to be installed.[53]

The drilling depth is also steadily increasing. The average drilling depth increased from 1,200 m. in 1965 to 1,900 m. in 1970 and is expected to exceed 2,000 meters in 1975.[53] However, in certain regions, including Komi A.S.S.R., the exploratory drilling depth now exceeds 3,000 m.,[25] and in Central Asia the new exploratory drilling is expected to be at depths of 3,000 to 5,000 m.[22] The drilling of deep and superdeep wells in Central Asia, Azerbaydzhan, Caucasus, and the Ukraine is extremely complicated by the anomalously high formation pressures (A.H.F.P.) and temperatures, by the instability of rock structures, and by other factors which are characteristic of geopressured zones. In recent years, large areas under such high pressures were discovered in Komi A.S.S.R., in the Orenburg region, in Belorussian S.S.R., and in Eastern Siberia. Deep exploratory drilling in the lower Volga region and Caspian syncline is troubled by complications caused by the A.H.F.P. Problems of accidental blowouts, wild wells, sticking of drilling equipment, lost circulation of flushing fluid, and decreased penetration rates in the regions with A.H.F.P. are so severe that they are now a primary concern of the U.S.S.R. Ministries of Oil, Gas, and Geology.[3]

Any considerable increase in natural gas production in Central Asia in the future will require stepped-up geological prospecting and exploration, installation of special equipment for developing productive gas fields with A.H.F.P.,[22] and extensive gas collecting networks. Production costs are likely to be high because of the prospective development of small, scattered, deep accumulations in the arid regions.

There is a pronounced gap between potential and proven gas reserves in the European north (Komi A.S.S.R.). With favorable results from geological prospecting and exploratory drilling, as well as with substantial capital investment, gas production in this area could be increased severalfold in the next decade. Geological prospecting and deep exploratory drilling in the most promising oil- and gas-bearing regions in the Pechora Basin would need to be stepped up to two to three times over its present level.[25]

The situation is very similar in the oil industry. Most major oil producing regions in the European U.S.S.R. have reached the secondary recovery stage, during which the oil production decreases at a rapid rate. Water flooding, injection of high-pressure gas, and finally thermal methods of recovery are now utilized to slow the decline of production in the older oil-producing regions. Indeed, Soviet estimates suggest that the production from these aging fields will drop by 160 to 170 million tons during the current five-year period, leaving oil production from these fields at about 180 million tons in 1975. Thus if the Soviets are to meet their goals for 500 to 510 million tons of oil output in 1975, over 300 million tons of oil will by then have to come from fields developed after 1970.[9] But in 1969 an official estimate of oil production from West Siberian fields—which are by far the largest and most promising—was only 100 to 120 million tons for 1975 and 230 to 260 million tons for 1980.[7,9] If the Soviet estimates are correct, then the question is obvious: Which new fields (excluding West Siberian) can be made to produce about 200 million tons of oil in 1975?

Fuel/Energy Cost

The published Soviet production costs of fuel (and raw materials) do not always include a number of incurred expenses and thus do not reflect the real fuel production costs in various regions. For example, not until after 1967 was the exceedingly high cost of geological prospecting and exploratory operations (partially) included in fuel production costs.[31,36] Yet in 1968 the U.S.S.R spent between 1.2 and 1.3 billion rubles for geological survey and exploratory operations for oil and gas. This sum represents approximately half of the funds allocated in that year for all geological and exploratory operations in the U.S.S.R. On the average, such geological operations constitute approximately 25 per cent of the cost of oil production, 50 per cent of the cost of gas production, 80 to 85 per cent of that for lead, and 40 per cent of that for copper.[36]

The new fuel prices still do not reflect regional developmental expenses, despite the fact that the cost of prospecting and exploration is a function of regional conditions.[36] Such distortion of production costs is particularly prevalent in the gas and oil industries, as is evidenced by a flat across-the-board addition of 1 ruble to the unit gas production cost for exploration—despite the fact that the variations in the costs of exploratory operations may be as high as 7 rubles per unit (and in some instances, even higher).[36]

Officially published production costs of Soviet fuels vary widely: The published production cost of fuel/energy in the European U.S.S.R. is considerably higher than in the Eastern U.S.S.R.[29] Soviet data show that the Siberian and Central Asian fuels are the cheapest, even though there are indications that the actual cost of Central Asian gas may be considerably higher, and

	Coal:		Gas:		Fuel oil:	Peat:
	Donets	Kuznets (strip mined)	Tyumen	Central Asia		
Leningrad	20.3	17.3	10.8	—	9.4	—
Moscow	18.4	16.1	10.0	13.3	8.1	11.6
Minsk	18.6	—	11.4	—	9.3	10.2
Gorkiy	18.8	15.0	10.0	—	7.7	—
Saratov	17.5	15.2	13.3	10.4	7.3	—
Donets	15.6	—	—	12.9	10.8	—

	Extraction cost	Transportation cost for 3,000 km.	Transport as a per cent of total cost at 3,000 km. from source
Natural gas:			
Tyumen	2.2	5.4	70
Central Asia	5.4	6.5	55
Oil:			
Tyumen	6.2	1.3	17
Mangyshlak	8.3	1.6	16
Coal:			
Kuznets (strip mined)	6.6	9.2	58
Ekibastuzsk	2.7	12.1	82
Kansko-Achinsk	1.8	15.4	90

Capital requirements for the development of fuel resources in the U.S.S.R. vary widely, and it is not clear that published figures reflect the full costs. The top table at the left shows the Soviet prices of various fuels in several principal industrial centers, and the table below it shows how differing extraction and transportation costs contribute to the prices of various fuels.[29] All costs are shown in rubles per ton of standard fuel equivalent.

thus would be comparable to the cost of the European fuels.[22] The tables on this page show that transportation considerably escalates the cost of fuel at the point of delivery; yet, almost invariably, the price of Siberian and Central Asian fuel is still lower than the price of the European fuel.

Soviet gas and oil prices have recently commenced an upward trend, as prices began to reflect the increasing developmental expenditures and higher production costs due to the gradual shift of oil and gas production to the newly developed deposits located in remote regions with difficult climatic conditions and in formations with complex geological structures.[15,53] Academician Khachaturov, commenting on the future redistribution of the Soviet oil industry and projected costs, has proposed that increased production and transportation costs will boost the average oil production cost by 40 to 45 per cent, making the price of oil in the European U.S.S.R. "higher than the price of coal. . . ."[15]

Energy from other sources in the demand areas is not inexpensive. The cost of electricity produced by the nuclear power plants is high. According to the Soviet energy expert, A. Probst, "current economic indicators of nuclear power plants are close to those of thermal electric power plants fired by Donets coal. . . . Under very optimistic assumptions, including the wide commercial use of fast neutron reactors, the cost of electricity generated by nuclear power plants could decrease by 30 to 50 per cent in the future. . . . However, the construction and wide use of the fast neutron reactors will be feasible only in 15 to 20 years."[30]

And so the Soviet energy policy makers are faced with a serious dilemma of skyrocketing energy shortages in their industrialized areas, the difficulties and uncertainties in developing their remote resources, increasing domestic energy costs, and the current high prices of foreign fuels. These factors have been mitigated by the "barter agreements" with Iran, Afghanistan, and other nations that predate the October War by many years. In these agreements, the basic price of oil/gas was established within a narrow fluctuation range. However, because such "barter-type" commitments are apparently not included in the officially published Soviet export/import figures (they do not come under the Central Statistical Bureau's foreign trade accounting classification[62]) the true volume of such Soviet fuel export/import is uncertain.

Energy-Intensive Industries

Extensive Soviet studies indicate that the nation's new energy-intensive industries must be located in Siberia. Yet the development of these industries in Siberia involves the solution of many problems, a number of which have been unsuccessfully tackled by the Soviets in the development of their fuel resources in these regions.

Soviet analyses show that the construction of new energy-intensive industries in the developed regions (European U.S.S.R. and Urals) and in Central Asia is not economically justified because of shortages of energy, water, and industrial land in these regions.[15,22,27,30,31,35] Soviet calculations show that the location of the energy-intensive industries in Siberia, in the proximity of the energy sources (coal and hydroelectric power), rather than in the energy-deficient European U.S.S.R. and Urals, would result in considerable eventual net savings, even if the raw materials were transported from the European U.S.S.R. and Urals to Siberia and the finished or semifinished products delivered back to these regions.[35] Should the Soviets find

outside funds to help them follow this option—for the required capital investment is staggering—then the expansion of industry in the European regions will probably be limited. The continued expansion of the industrial base (including the energy-intensive industries) in the European U.S.S.R. and the energy/raw material base in Siberia would require a smaller initial capital investment, yet in the long run the cost will be huge and the effects on the Soviets' prospective economic performance, in all probability, would be disastrous. For example, the loss of large tracts of valuable agricultural land will have to be offset by the development of virgin lands for agricultural purposes, many of which would require extensive irrigation systems. Escalating water shortages will require mammoth water projects—possibly re-channeling of Siberian rivers.[8,22] The development of transportation facilities will be needed to carry bulky cargo—with one-way, east to west, heavy traffic. In addition, the high cost of fuel in the European regions will have an adverse effect on industrial production costs.

However, development of energy-intensive industries as well as fuel and raw material resources in the Siberian territories presents many problems, including the need for new technology,[1] greatly increased capital investment due to increased construction costs and the development of new infrastructure,[1,15,22] lack of and problems with labor,[1,22] and the inadequate supply of consumer goods, including food.[10,13] But the Soviets have a real need to develop the fuel and raw material base there,[10] and, despite the magnitude of developmental problems, they are planning grandiose industrial developments in these regions.

The construction of a new transportation system is imperative for the development of the resources of Siberia. The existing east-west railroad system located in southern Siberia is heavily congested, and roads and railroads are practically non-existent in the newly developing regions. The airway network is well developed; it reaches every larger settlement. But it is completely uneconomical, especially for the transport of bulky freight. Siberia's mighty rivers are little suited for transportation: They flow to the north, contrary to the flow of transport traffic, and are closed to winter navigation. Because of the extremely harsh environmental conditions, the development (and maintenance) of an adequate transportation system in Siberia will be a particularly costly, prolonged, and complex undertaking, which in many instances will require the development of new construction techniques as well as new technology.[1,8,22,38,47,58]

The cost of construction in Siberia is escalated by the harsh environmental conditions[8] as well as by the absence—in many areas—of construction materials and/or the requisite construction industries. Permafrost, combined with extremely icy conditions and low temperatures, ground movement, swamps, and, in many cases, seismic conditions increase considerably the cost of construction.[1,8] Frequent strong winds require specially reinforced construction for towers for electric transmission lines and television and radio antennas, and for railroad bridge supports, reservoirs, and other standard structures.[8] In addition, the cost of developmental and production operations is greatly increased due to the lack of proper technology, equipment suitable for the arctic and subarctic operations, and proper repair facilities.[8]

The development of the new territories is further complicated by labor problems, for the Soviet Union (with the exception of Central Asia and Moldavia) is experiencing an increasing labor shortage. The labor shortages are particularly acute in Siberia[13] for a number of reasons, including the lack of local labor resources and the net negative migration in Siberia (with the exception of the Far East). The migration from Siberia is caused primarily by the substandard living conditions, by acclimatization difficulties, and by the high cost of living and the scarcity of consumer goods.[13,22,38]

The high rate of labor turnover is particularly detrimental to the developing new industries in Siberia, especially during the start-up stages.[22] Also, because of the labor scarcity, a number of industries do not operate at full capacity.[13]

It is interesting to note that the recent agreements between the Soviets and the Comecon countries on the development of Siberian resources and industries include, in addition to Comecon's credits, the supply of labor from Comecon countries.[43,55]

Capital Investment

There are strong indications that the Soviet Union is not able to bear the economic burden of developing fuel/energy resources and, at the same time, of significantly expanding her industrial base, for the burden is being compounded by escalating construction costs, an inadequate technological base, labor problems, and a lack of the required capital.

Total capital investment in the Soviet Union has been steadily increasing. But the demand for capital investment funds has been well ahead of their availability, and the capital investment needs have not been met in a number of industries and sectors.[25,28] Even though the Soviets are desperately trying to expand their fuel/energy industry, the capital investment in this critical sector has not been adequate to achieve the desired results.[25,41] Yet the sums invested in this sector have been sizeable: The direct capital investment in the fuel/energy industry averaged about 30 per cent of the total capital investment in industry during the 1960s. In addition, large sums have been invested in the fuel/energy industrial support base, as well as in geological prospecting and exploration. But a large portion of the funds invested in geological survey and prospecting operations remains "frozen," because a large proportion of the recorded reserves will not be commercially developed in the foreseeable future.[15] The escalating construction costs only increase the demand for scarce investment funds, and they have a particularly detrimental effect on the development of the remotely located natural resources.[1,10]

Because of the capital intensiveness of the extracting industries, the lack of the requisite funds, and certain political considerations, the Soviets have been stepping up the participation of Comecon countries in the development of Soviet natural resources, pipelines, and industry. Furthermore, for a number of reasons, including the burden of heavy capital investment in the domestic fuel industry, the Soviet Union has been expanding its imports of fuels and raw materials from the "developing countries" and has been encouraging her Comecon partners to seek non-Soviet

fuel supply sources.[11,28,40]

Yet even with Comecon countries' assistance in the form of credits, technology, and labor, the Soviet Union is apparently not able to handle the development of her resources and the requisite industrial base. Thus the Soviet Union is faced with a profound problem of financing her economic expansion—which is well above her means and which is forcing her to seek credits, technology, and assistance in the West.[22,43]

Energy: The Soviets' Achilles Heel?

A study of the Soviet energy posture and policy, as delineated in Soviet publications, leads one to the conclusions that the Soviet Union is faced with an energy crisis of its own, that her approach to solving that problem is likely to be international in nature, and that her attempted resolution of that crisis is likely to cause political and economic perturbations on the international scene.

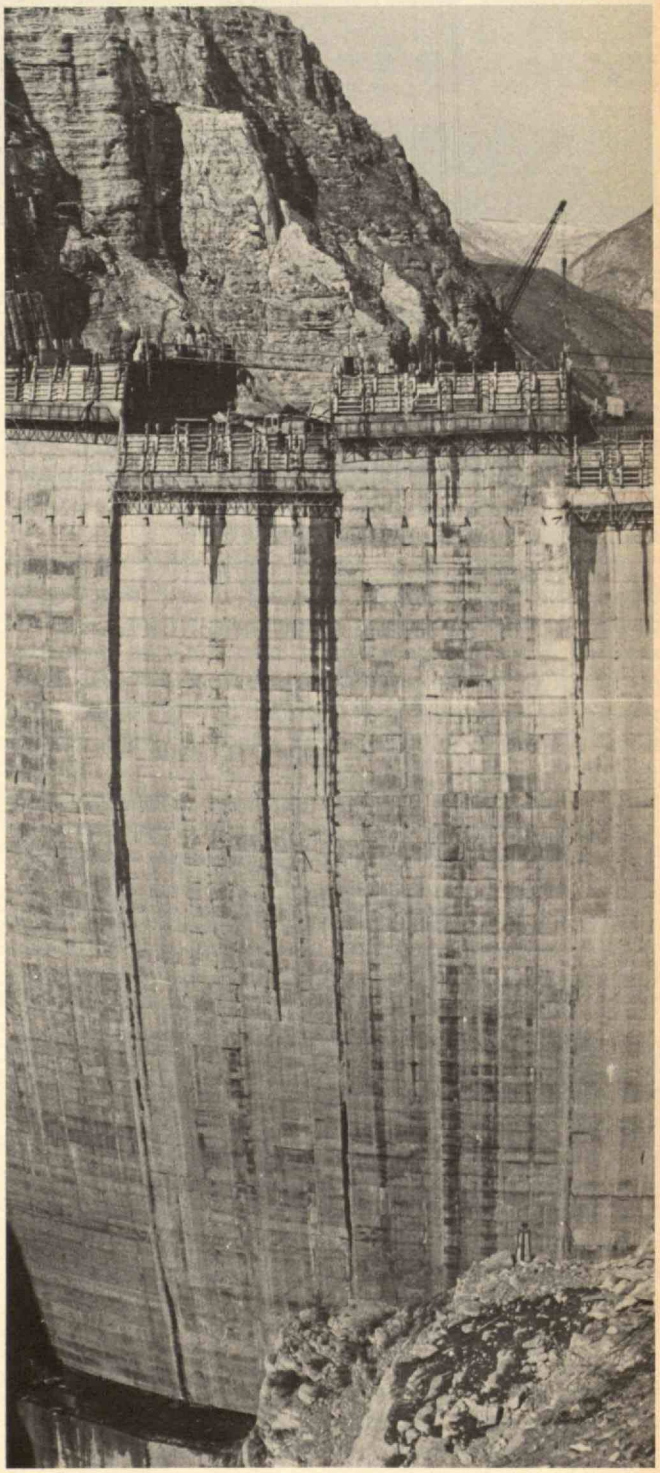
The implications of the true state of the Soviet energy situation and related problems of industrial development are far-reaching and numerous. Only some of these implications have been considered in this article—and only those which seem pertinent to the trade negotiations which are now being conducted with the Soviet Union. It is hoped that an understanding of the state of Soviet energy supplies and related economic problems, as perceived by the Soviets, will not only put the trade negotiations in a proper perspective, but will also considerably strengthen the Western bargaining position.

Just what are the long- and short-term benefits which the West might derive from developing Soviet resources and supporting the Soviet economy? What advantages do the Soviets seek in trying so desperately to penetrate Western trade barriers? In negotiations with the West, Soviet overtures have ranged from seeming indifference, to coaxing, to hints of taking their allegedly lucrative business somewhere else. Yet Soviet publications clearly show that the recent Soviet push for long-term, low-interest credits for the acquisition of Western high technology, equipment, and technological and managerial expertise has been motivated primarily by economic necessity.

The immediate and long-term benefits to the Soviet Union of Western technological assistance (and credits) are high: Western help could unquestionably moderate the Soviet energy shortage, would expedite Soviet economic growth, and would aid the Soviet Union in establishing the transportation network for the "Unified Soviet-West European Energy System." In addition, Western help would probably allow the Soviets to maintain or even increase their commitments to their military establishment and to various interests in the underdeveloped countries and their investments in multinational corporations.

Should the Soviets be unsuccessful in shifting some of the burden of developing their economy onto the West, they will be faced with a difficult priority choice in the allocation of their funds. Indeed, it is possible that the vastly increased allocations needed for planned industrial development might adversely affect the Soviets' ability to support the planned expansion of their military establishment. On the other hand, insufficient funding of the planned economic expansion, but continued commitments to the military

This Chirkeiskaya hydroelectric plant is under construction in the North Caucasus (Daghestan A.S.S.R.)—formerly a major gas-producing area. It is an illustration of the statement that "despite the high degree of utilization of hydroelectric potential and the relatively unfavorable economic indicators for the production of electric power in the European part of the country, it is necessary to continue the development of hydroelectric plants because of growing difficulties in meeting peak load demands."[35] Siberian hydropower sites—most of them within or near the Arctic Circle on north-flowing rivers—present severe environmental and technical problems and are far from the Soviet energy-demand centers. (Photo: Tass from Sovfoto)



In summer the taiga of West Siberia is a vast marshy forest, in winter a frozen wasteland. Through such terrain the Soviets must build fuel transportation facilities if they are to exploit the Tyumen oil and gas deposits. This 500-km. gas pipeline, shown under construction during the winter of 1973-74, will bring fuel to the industrial center of the Urals; another 1,500 km. of line would be required to bring gas to the energy-demand centers of the European U.S.S.R. (Photo: Tass from Sovfoto)

sector, would undoubtedly exacerbate the already-bleak Soviet energy situation, would undoubtedly retard the development of Soviet industrial potential, and hence would have an increasingly detrimental effect on the Soviet Union's overall power posture.

The magnitude of the Soviet energy dilemma and of related problems is also reflected in the urgency of Soviet attempts to obtain Western technology and assistance. Even though a Soviet assessment of the state-of-the-art in Western technology indicates a clear preference for American high technology, the Soviets have been actively negotiating with other Western nations and have been exploring other alternatives. Should the Soviets not be able to negotiate directly for the technology transfer desired from the West, they may still obtain that technology by using much slower and more indirect routes—through increasing direct involvement in multinational corporations, which can be used as technology transfer agents and which can also be exploited and then nationalized, thereby meeting both economic and ideological desiderata.

While it is generally agreed that U.S. trade with the Soviet Union will open up new markets for the near future, the question of long-term benefits to the West remains unclear, particularly in view of the Soviet energy crisis. The possibility of opening up new supply sources for oil and gas, often cited as a reason for Western investments in the U.S.S.R., should be seriously questioned by Western business, for neither the true size of Soviet oil and gas resources, nor the likely costs of their development, are known even to the Soviets, much less to the West.

The probability either of limited Soviet hydrocarbon fuel resources or of excessive real costs for Soviet oil and gas when available should certainly enter into a decision about undertaking the investment needed by the Soviet economy. Furthermore, a realization of the dimensions of the Soviet energy problem and other economic difficulties should unquestionably give the West added bargaining power in the negotiation of trade agreements with the Soviets and provide a basis for requiring assurance of alternative modes for the repayment of loans by the Soviet Union. In view of the Soviet economic difficulties, it would seem prudent that Western investment and effort be carefully weighed. Would equal investment in a concerted effort toward developing alternate sources of energy for the United States in the long run prove to be much more advantageous?

References

The following biblography contains the principal documents used by the author in the study of Soviet fuel/energy resources and policies which is summarized in this article. Superscripts in the text refer to the numbers assigned to each reference; an annotated bibliography, including page references for each citation and some key passages in translation, has been provided by the author and is available on request from the Editors of the *Review*.

1. Agranat, G. and V. Loginov, "Ekonomicheskiy opyt SSSR v osvoyenii Severa," *Voprosy ekonomiki*, #11, November 1972, pp. 3-14.
2. Alampiyev, P. M., O. T. Bogomolov and Yu. S. Shiryayev, *Ekonomicheskaya intergratsiya—ob'yektivnaya potrebnost' razvitiya mirovogo sotsializma*, Moscow, Mysl', 1971.
3. Anikiyev, K. A., *Prognoz sverkhvysokikh plastovykh davleniy i sovershenstvovaniye glubokogo bureniya na neft' i gaz*, Leningrad, Nedra, 1971.
4. Bogatko, S., *Kholodna li Sibir'*, Moscow, Politizdat, 1971.
5. Brezhnev, L. I., *Otchetnyy doklad Tsentral'nogo Komiteta KPSS XXIV s'yezdu Kommunisticheskoy Partii Sovetskogo Soyuza, 30 marta 1971 goda*, Moscow, Politizdat, 1971.
6. Burshtar, M. S., *Osnovy teorii formirovaniya zalezhey nefti i gaza*, Moscow, Nedra, 1973.
7. Chernenko, K. U., and M. S. Smiryukov (eds.), *Resheniye partii i pravitel' stva po khozyaystvennym voprosam*, Vol. 5, 1962-1965, Moscow, Politizdat, 1968, Vol. 6, 1966-June 1968, Mos-

cow, Politizdat, 1968, Vol. 7, June 1968-1969, Moscow, Politizdat, 1970, Vol. 8, 1970-February 1972, Moscow, 1972.
8. Dogayev, Yu. M., et al. (eds.), *Problemy Severa,* Issue #17, Moscow, Nauka, 1972.
9. Galonskiy, P., "Neftyanaya, gazovaya i neftepererabatyvayushchaya promyshlenost' v 1971-1975 gg.," *Planovoye khozyaystvo,* #11, November 1972, pp. 31-39.
10. Granik, G. I., et al., (eds.), *Problemy Severa,* Issue #16, Moscow, Nauka, 1972.
11. Inozemtsev, N. "Glavnyye zadachi koordinatsii narodnokhozyaystvennykh planov stran SEV," *Planovoye Khozyaystvo,* #4, April 1973, pp. 6-14.
12. Isayev, V., "Puti povysheniya effektivnosti kapital'nykh vlozheniy," *Voprosy ekonomiki,* #8, August 1973, pp. 30-40.
13. Ivanova, R., "O razvitii vostochnykh rayonov i obespechenii ikh rabochey siloy," *Voprosy ekonomiki,* #1, January 1973, pp. 40-48.
14. Kalesnik, S. V. and V. F. Pavlenko (eds.), *Sovetskiy Soyuz. Obshchiy obzor,* Moscow, Mysl', 1972.
15. Khachaturov, T., "Prirodnyye resursy i planirovaniye narodnogo khozyaystva," *Voprosy ekonomiki,* #8, August 1973, pp. 16-29.
16. Kortunov, V. V. and Ye. I. Kuskov (eds.), *Spravochnik propagandista—mezhdunarodnika,* Moscow, Politizdat, 1973.
17. Kozlov, I. D. and Ye. K. Shmakova, *Sotrudnichestvo stran—chlenov SEV v energetike,* Moscow, Nauka, 1973.
18. KPSS (Kommunisticheskaya Partiya Sovetskogo Soyuza), *Direktivy XXIV s'yezda KPSS po pyatiletnemu planu razvitiya narodnogo khozyaystva SSSR na* 1971-1975 gody, Proyekt, Moscow, Politizdat, 1971.
19. ———, *XXIV s'yezd Kommunisticheskoy Partii Sovetskogo Soyuza, Stenograficheskiy otchet, 30 marta—9 apr. 1971 g, vol. II,* Moscow, Politizdat, 1971.
20. Kudinov, V. and S. Litvak, "O toplivno-energeticheskom balanse," *Vestnik statistiki,* #9, September 1972, pp. 35-46.
21. Lavrishchev, A. N., *Ekonomicheskaya geografiya SSSR,* Moscow, Ekonomika, 1972.
22. Mazanova, M. B., "Rol' vostochnykh rayonov v ekonomike SSSR," in M. B. Mazanova, *Problemy razvitiya vostochnykh rayonov SSSR,* Moscow, Nauka, 1971.
23. Mel'nikov, N., "Ratsional'noye ispol'zovaniye prirodnykh resursov," *Kommunist,* #15, October 1973, pp. 78-90.
24. Mirlin, G., "Mineral'nyye bogatstva SSSR," *Planovoye khozyaystvo,* #11, November 1972, pp. 22-30.
25. Parashchenko, G. N. (ed.), *Regional'nyye osobennosti i effektivnost' promyshlennogo proizvodstva na Severe,* Moscow, Nauka, 1972.
26. Paton, B. Ye., Interview in *Ekonomika i organizatsiya promyshlennogo proizvodstva,* #5, September-October 1973, Novosibirsk, Nauka, pp. 3-13.
27. Pavlenko, V., "Territorial'nyy aspekt dolgrosrochnogo plana," *Planovoye khozyaystvo,* #5, May 1973, pp. 9-16.
28. Pomazanov, S., "Formirovaniye narodnokhozyaystvennogo kompleksa v SSSR," *Voprosy ekonomiki,* #9, September 1972, pp. 3-13.
29. Probst, A., "Puti razvitiya toplivnogo khozyaystva SSSR," *Voprosy ekonomiki,* #6, June 1971, pp. 51-63.
30. ———, "O dolgosrochnoy perspektive razmeschcheniya proizvodstva," *Voprosy ekonomiki,* #5, May 1973, pp. 17-30.
31. Probst, A. Ye. (ed.), *Razvitiye toplivnoy bazy rayonov SSSR,* Moscow, Nedra, 1968.
32. Prokhorov, G. M., *Vneshneekonomicheskiye svyazi i ekonomicheskiy rost sotsialisticheskikh stran,* Moscow, Mezhdunarodnyye otnosheniya, 1972.
33. Ravich, M. B., *Toplivo i effektivnost' yego ispol'zovaniya,* Moscow, Nauka, 1971.
34. Rybakov, O., "Nekotoryye organizatsionno-metodologicheskiye voprosy razrabotki perspektivnykh planov sotrundnichestva SSSR s sotsialisticheskimi stranami," *Planovoye khozyaystvo,* #4, April 1973, pp. 35-43.
35. Ryl'skiy, V. A., *Ekonomika mezhrayonnykh elektroenergeticheskikh svyazey v SSSR,* Moscow, Nauka, 1972.
36. Sakharov, V., "Otrazheniye zatrat na geologorazvedochnyye raboty v izderzhkakh neftedobyvayushchey promyshlennosti," *Planovoye khozyaystvo,* #8, August 1973, pp. 65-71.
37. Savenko, Yu. N. and Ye. O. Shteyngauz, *Energeticheskiy balans,* Moscow, Energiya, 1971.
38. Savin, S. I., *Formirovaniye territorialno-proizvodstvennykh kompleksov Vostochnoy Sibiri,* Moscow, Nauka, 1972.
39. Sergeyev, M., "The Urals Center," *Izvestiya,* 26 August 1973, p. 3 as translated in the Current Digest of the Soviet Press, Vol., XXV, #34, 1973, p. 10.
40. Sergeyev, V. A., "Ekonomicheskoye sotrudnichestvo SSSR s razvivayushchimisya stranami Azii," *Problemy Dal'nego Vostoka,* #3, July, September 1973, pp. 15-28.
41. Shashin, V., "Puti povysheniya effektivnosti neftyanoy promyshlennosti," *Planovoye khozyaystvo,* #4, April 1973, pp. 15-22.
42. Shiryayev, Yu. S. and S. M. Ivochuk, *Proizvodstvennaya intergratsiya stran SEV,* Moscow, Nauka, 1972.
43. Shmakova, Y., "The CEMA Countries' Co-Operation in Developing Fuel and Power Resources," *Foreign Trade,* #2, February 1973, pp. 5-8.
44. Shmelev, D., "Neukosnitel'no soblyudat' planovuyu distsiplinu," *Planovoye khozyaystvo,* #5, May 1973, pp. 113-124.
45. Skachkov, S., "Equality and Mutual Advantage," translated from Pravda, 29 March 1973, Supplement to *Foreign Trade,* #5, 1973.
46. Slavin, S. V., The Soviet North (Translation from Russian), Moscow, Progress Publishers, 1972.
47. Slavin, S. V., et al. (eds.), *Problemy Severa,* Issue #12, Moscow, Nauka, 1967.
48. Sokolov, B. A., et al., *Neftegazonosnost' morey i okeanov,* Moscow, Nedra, 1973.
49. Solov'yeva, A. M. (ed.), *Kompleksnoye ispol'zovaniye vodnykh resursov,* Moscow, Nauka, 1972.
50. Solovyov, B., "Co-operation with the U.S.S.R.—An Important Factor in Strengthening the Independence of the Developing Countries," *Foreign Trade,* #10, October 1973, pp. 4-10.
51. Sukhanov, Y., *From the Urals to the Pacific* (Translated from Russian), Moscow, Progress Publishers (no date).
52. TsSU (Tsentral'noye statisticheskoye upravleniye, USSR), *Narodnoye khozyaystvo SSSR 1922-1972 gg.,* Moscow, Statistika, 1972.
53. Urinson, G. S., I. S. Tyshlyar and M. M. Khosh, *Ekonomika razrabotki gazovykh mestorozhdeniy,* Moscow, Nedra, 1973.
54. Vekshin, G., "The Economic Co-operation of the U.S.S.R. in 1972, Facts and Figures," *Foreign Trade,* #5, May 1973, pp. 8-12.
55. Vorov, N., "Osnovnyye napravleniya razvitiya sotrudnichestva stran—chlenov SEV v razvitii toplivno-energeticheskoy i syr'yevoy bazy," *Planovoye khozyaystvo,* #7, July 1971, pp. 49-56.
56. Yefimov, A. V., et al. (eds.), *Letopis' Severa, Vol. VI,* Moscow, Mysl', 1972.
57. Zamakhayev, V. S., et al. (eds.), *Ispol'zovaniye vody v narodnom khozyaystve,* Moscow, Energiya, 1973.
58. Zaytsev, I. F. and O. A. Izyumskiy, *Prirodnyye resursy—na sluzhbu ekonomicheskomu progressu,* Moscow, Mysl', 1972.
59. Zevin, L., "Voprosy povysheniya ustoychivosti i effektivnosti ekonomicheskikh svyazey SSSR s razvivayushchimisya stranami," *Planovoye khozyaystvo,* #7, July 1971, pp. 17-26.
60. Zhmuyda, V. B., et al. (eds.), *Sredneaziatskiy ekonomicheskiy rayon,* Moscow, Nauka, 1972.
61. Zolotarev, V. I., *Programma ekonomicheskogo sotrudnichestva sotsialisticheskikh stran,* Moscow Mezhdunarodnyye otnosheniya, 1973.
62. *Vneshnyaya. torgorlya SSSR Za 1972 gg.,* Moscow, 1973 (p. 271).

Marianna Slocum holds undergraduate (S.B. 1955) and graduate (S.M. 1959) degrees from M.I.T. in physics and mathematics. For the past several years, she has been analyzing the interactions of technology, energy policy, systems planning, economics, and strategy.

The Calculus of Nuclear Counterforce

"The United States has always had a considerable margin of superiority over the Soviet Union in nuclear weapons."

Nuclear warheads and the missiles that transport them to their targets are rarely discussed in any detail in public. This is often attributed to the necessary secrecy that surrounds these weapons, and to their technical complexity, although there is enough information, publicly available and relatively straightforward, to form the basis for public debate. It is also argued that the intricate technical details of these weapons are not relevant to public debate, because other factors, such as political perceptions or appearances, psychological pressures, and bureaucratic expediency, may be more influential. The public and the politicians, it is frequently said, understand simple concepts—the number of missiles various countries possess, and the physical size of the rockets—but not such intangibles as accuracy or reliability. Yet it is these latter performance parameters, not the numbers and sizes of launchers, that are actually important.

This is especially true following Secretary of Defense James Schlesinger's announcement, on January 10, 1974, that the U.S. plans to acquire a missile force that can efficiently destroy enemy land-based missiles in their silos. This new strategy of "counter-force," in effect proposed by Mr. Schlesinger, is based on nuclear weapon properties that are different from the properties of "counter-value" weapons—weapons that can destroy an enemy's cities and industrial sites rather than an enemy's weapons. Yet the debate in the Congress, the academic community, and the U.S. press following Mr. Schlesinger's announcement has contained very little analysis of the performance parameters of the proposed weapons as compared with those of the existing ones. Arguments and counterarguments concerning the future capabilities of U.S. and Soviet strategic arsenals continue to be based on the aggregate number and physical size of weapons, parameters which may be relevant in a comparison of countervalue capabilities but have limited importance in an analysis of counterforce capabilities. As a result, the entire public debate on a future nuclear policy for the United States is based on physical parameters and performance properties that are largely irrelevant to the task of destroying missiles in their silos, and there is a good chance that the conclusions of the public debate will be at best irrelevant and most probably erroneous and misleading.

An examination of the U.S. and Soviet arsenals, based on parameters relevant to a strategy of counterforce, reveals that the United States has always had a considerable margin of superiority and that this superiority will continue, even if no new programs are initiated. Furthermore, it shows that if the new programs are pursued to their completion they will result in at least two unfavorable developments: nuclear war will become more probable, and the Soviet military will find justification to demand from their political leadership new missile construction programs beyond the present one that entails replacement of their second-generation missiles with ones that carry multiple warheads (MIRV's). Such an event will virtually guarantee that the accumulation of increasingly sophisticated missiles on both sides will continue, and will not stop until the weapons of both countries reach the limits of sophistication imposed by the properties of matter.

The first section of this article presents and contrasts the properties of nuclear weapons that are relevant in a countervalue and a counterforce attack. The second section is mathematical; its purpose is to derive a parameter that describes the performance of a nuclear weapon in an attack on an enemy missile silo. That parameter is the lethality, K, of a warhead; it will turn out to increase with the two-thirds power of the warhead's yield (that is, its release of energy) and with the square of the warhead's accuracy. Knowing this, the reader uninterested in the mathematical details can skip to the article's third section, which uses K to analyze the existing and proposed weapons of the U.S. and Soviet arsenals. The final section presents conclusions that can be drawn from this analysis.

I. The Physics of Nuclear Attack

A land-based intercontinental ballistic missile (ICBM) consists of a rocket, usually a multi-stage arrangement, propelled by a solid-fuel motor and guided by an inertial guidance system. It carries either a single re-entry vehicle containing a nuclear explosive warhead, or in the case of MIRV, several re-entry vehicles, each containing a nuclear warhead and capable of being independently targeted. Each warhead may weigh as little as a few tens of kilograms since the nuclear charge itself may weigh as little as 20 to 30 kilograms.

The destructive effect of a nuclear weapon results from the almost instantaneous release of enormous amounts of energy: the explosion of a one-megaton warhead releases, within a few billionths of a second, energy equivalent to that released by the explosion of one million tons of TNT, generating, in the immediate vicinity of the explosion, temperatures of millions of degrees centigrade. This enormous heat causes the sudden

Kosta Tsipis
Stockholm International
Peace Research Institute,
and the Center for International
Studies, M.I.T.

expansion of the air around the point of explosion, which in turn gives rise to a shockwave in which pressures reach 100,000 pounds per square inch (about 7,000 atmospheres). The pressure rapidly decreases as the shockwave propagates outward from the point of explosion.

Although the same nuclear warhead can be used against a city or industrial complex (countervalue attack) or against a reinforced concrete silo housing a missile (counterforce attack), the performance characteristics of the warhead and the missile that are relevant to each type of attack are very different. Shockwave overpressure (pressure above normal atmospheric) of only 20 pounds per square inch will usually kill an unprotected human being, while overpressure of five pounds per square inch will demolish an ordinary brick house. Since overpressure increases with the energy released by a nuclear charge and decreases with the cube of the distance from the point of explosion, the larger the energy yield of the weapon the further from its point of impact will be the perimeter of total destruction. A one-megaton nuclear weapon, for example, will create a five-pounds-per-square-inch overpressure four kilometers from the point of explosion, and will thus destroy all houses in an area of 50 square kilometers surrounding its point of impact. Therefore, a missile aimed at a city (a countervalue attack) does not have to be very accurate, since the destruction of property and life caused by the weapon will be immense, no matter where in the city it lands.

While blast effects can prove fatal to people, by far the most lethal effect of a nuclear explosion is the thermal radiation released: the fireball created by a nuclear blast attains temperatures of tens of millions of degrees centigrade and therefore radiates energy very much like the sun. So nuclear weapons, unlike conventional weapons, destroy both buildings and human beings by direct thermal effects and by the fires and firestorm induced by the heat released in the explosion. Both the direct and induced thermal effects, whose magnitudes are proportional to the size of the warhead, extend to great distances from the point of explosion: the heat released by a one-megaton nuclear explosion will cause paper to ignite 14 kilometers away. An idea of the destructiveness of these thermal effects can be gained from the fact that about 50 per cent of the fatalities caused by the Hiroshima bomb (whose yield was about 15 kilotons—15,000 tons of TNT equivalent) were due to primary or induced thermal effects, 30 per

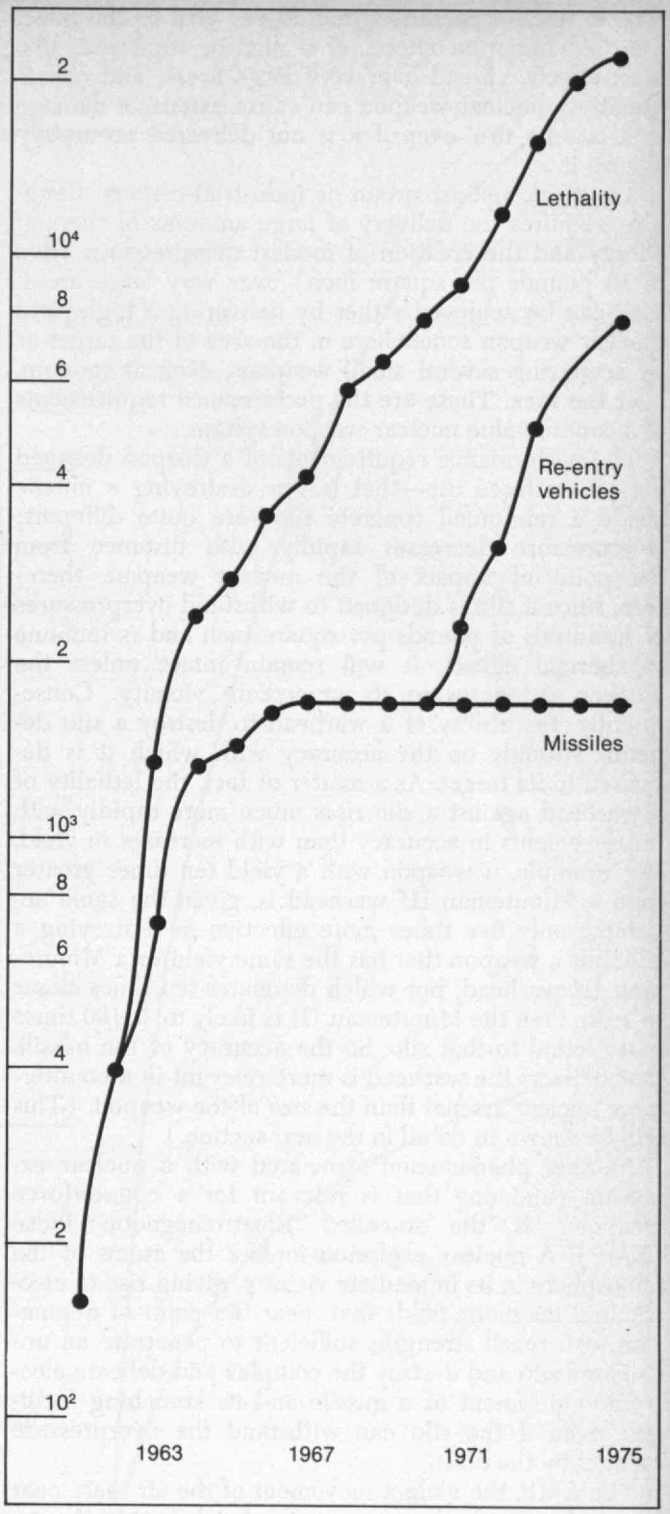


Chart 1 displays three numbers that can be used to describe the U.S. missile arsenal. (For all three, the vertical scale is logarithmic.) The bottom line traces the rise in number of missiles—a number that is often used in public debates about the relative strengths of American and Soviet forces. The American number has remained constant, at 1,710, since 1967. Yet the American number of independently targetable re-entry vehicles (middle line) has continued to rise, due to the advent, in 1971, of MIRVing, which allows a single missile to carry several warheads to separate targets. The top line shows the steady rise of the total "lethality" of U.S. missiles. The lethality is a measure of the effectiveness of missiles when used in an attempt to destroy enemy missile silos; as described in the text, the lethality of a warhead depends upon its explosive energy, but to a far larger extent upon the accuracy with which the warhead is expected to arrive at its target.

cent to nuclear radiation, and 20 per cent to the blast. Thermal radiation effects of a nuclear explosion, like blast effects, spread over very large areas, and consequently a nuclear weapon can cause extensive damage to a city by fire, even if it is not delivered accurately against it.

An attack against urban or industrial centers, therefore, requires the delivery of large amounts of thermal energy and the creation of modest overpressures (five to 10 pounds per square inch) over very large areas. This can be achieved either by delivering a high-yield nuclear weapon somewhere in the area of the target or by scattering several small weapons, even at random, over the area. These are the performance requirements of a countervalue nuclear-weapon system.

The performance requirements of a weapon destined for counterforce use—that is, for destroying a missile inside a reinforced concrete silo—are quite different: Overpressure decreases rapidly with distance from the point of impact of the nuclear weapon; therefore, since a silo is designed to withstand overpressures of hundreds of pounds per square inch and is immune to thermal effects, it will remain intact unless the weapon detonates in its immediate vicinity. Consequently, the ability of a warhead to destroy a silo depends strongly on the accuracy with which it is delivered to its target. As a matter of fact, the lethality of a warhead against a silo rises much more rapidly with improvements in accuracy than with increases in yield. For example, a weapon with a yield ten times greater than a Minuteman III warhead is, given the same accuracy, only five times more effective in destroying a silo, but a weapon that has the same yield as a Minuteman III warhead, but which detonates ten times closer to a silo than the Minuteman III is likely to, is 100 times more lethal to that silo. So the accuracy of the missile that delivers the warhead is more relevant in a counterforce nuclear arsenal than the size of the weapon. (This will be shown in detail in the next section.)

Another phenomenon associated with a nuclear explosion (and one that is relevant for a counterforce weapon) is the so-called Electromagnetic Pulse (EMP). A nuclear explosion ionizes the atoms of the atmosphere in its immediate vicinity, giving rise to electric and magnetic fields that, near the point of detonation, can reach strengths sufficient to penetrate an unshielded silo and destroy the complex and delicate electronic equipment of a missile and its launching facilities, even if the silo can withstand the overpressure created by the blast.

The EMP, the violent movement of the air mass near the explosion, the large amounts of debris that the explosion causes to rise rapidly into the upper atmosphere, and the persistently high level of radioactivity emanating from the expanding fireball, combine to create another effect, known as "interference," "screening," or "fratricide" (the latter term was coined by the Pentagon). All these terms refer to the fact that the results of a nuclear explosion make it difficult, if not impossible, to deliver a re-entry vehicle to the same point, soon after an earlier one has arrived and detonated. As the second re-entry vehicle enters the atmosphere near the point where the first exploded, it encounters high densities of dust that can cause its protective shield to burn prematurely, or it can be deflected off-target by the violent winds that persist in the area for considerable periods of time, or, if it arrives a few seconds after the first weapon, it could even be destroyed by the EMP or the nuclear radiation emanating from the rising fireball. Thus, the interference effect does not physically forbid the use of several re-entry vehicles against the same silo, but renders such a targeting schedule inefficient and uncertain.

An attacker can, of course, attempt to avoid the interference effect by timing the arrival of re-entry vehicles at a target so that the first will not affect the second and so on. Moreover, some of the effects of a nuclear explosion that interfere with the accurate arrival of re-entry vehicles in rapid succession at a missile silo, also prohibit the missile housed in that silo from being launched. This so-called "pin-down" effect therefore moderates the importance of the interference effect. The pin-down effect, in conjunction with possible damage to the missile caused by the EMP, may be used to facilitate the use of bombers against silos. Bombers can penetrate into the vicinity of the silos and deliver a large nuclear weapon with an accuracy of a few tens of meters while the missiles in the silos of a missile-farm are kept pinned down by the carefully timed arrival of re-entry vehicles.

The uncertainties introduced by these two effects and their interaction are such that a missile force cannot be considered to possess unmistakable capabilities against a silo unless it includes weapons with yield and accuracy high enough to destroy a silo with a *single* re-entry vehicle. Even if a MIRVed missile has, in principle, enough warheads with enough accuracy and yield to destroy a silo with certainty, it is doubtful that it has this capability in real life. The first re-entry vehicle that reaches the silo would probably cause the destruction or the wandering off-target of all subsequent ones. Therefore the interference effect must always be born in mind when calculating the countersilo attack capability of a country that does not possess missiles accurate enough to destroy a silo with a single warhead.

II. The Calculus of Destruction

The overpressure, Δp pounds per square inch (p.s.i.), created at a distance r nautical miles from the point of detonation of a nuclear warhead with an explosive yield of Y megatons (millions of tons of TNT equivalent) is given by the empirical formula:

$$\Delta p = 14.7\frac{Y}{r^3} + 12.8\left(\frac{Y}{r^3}\right)^{1/2} \qquad (1)$$

Dividing both sides by 12.8 and making the change of variables,

$$\left(\frac{Y}{r^3}\right)^{1/2} = \alpha, \qquad (2)$$

we get:

$$\frac{\Delta p}{12.8} = 1.15\,\alpha^2 + \alpha, \qquad (3)$$

a second-order polynomial in α, which we solve by use of the quadratic formula.

$$\alpha = \frac{-1 \pm (1 + 0.36\,\Delta p)^{1/2}}{2.3} \qquad (4)$$

If Δp is large, the 1 within the square-root term can be ignored. Throughout this article, Δp will take on values of at least 300 p.s.i., so the error introduced by our simplification will be less than 1 per cent. Therefore:

$$\alpha = \left(\frac{Y}{r^3}\right)^{1/2} = -0.435 \pm 0.26\,\Delta p^{1/2} \qquad (5)$$

Squaring both sides:

$$\frac{Y}{r^3} = 0.19 - 0.23\,\Delta p^{1/2} + 0.068\,\Delta p \qquad (6)$$

where only the positive solution of equation (5) is retained (the negative is aphysical).

Rearranging equation (6), an expression for r in terms of Y and Δp is obtained.

$$r^3 = \frac{Y}{\Delta p\{0.19\,\Delta p^{-1} - 0.23\,\Delta p^{-1/2} + 0.068\}}$$

$$= \frac{Y}{\Delta p\{f(\Delta p)\}} \qquad (7)$$

All the terms within the brackets have been subsumed under the name $f(\Delta p)$. Finally, taking the cube root of both sides:

$$r = \frac{Y^{1/3}}{\Delta p^{1/3}\{f(\Delta p)\}^{1/3}} \qquad (8)$$

Now let the hardness, H, of a missile silo, measured in p.s.i., express the greatest overpressure that the silo is able to withstand for a given duration of time. If a nuclear warhead explodes at a distance from a silo such that it creates an overpressure Δp at the silo equal to or less than its hardness H, the silo is expected to survive, but if the warhead explodes nearer to the silo than a certain distance r_s, creating an overpressure greater than H, the silo will be destroyed.

A common model in ballistics is to suppose that the point (0, 0) in the (x, y) plane is being fired at, and that the x and y coordinates of the point the missile actually hits have Gaussian distributions—that is, if many attempts are made to hit (0, 0), and the x and y coordinates of the actual points of impact are separately plotted, the two graphs will be familiar bell-shaped curves, each centered at 0. Using this model, the probability that a re-entry vehicle will explode at a distance from the silo equal to or greater than r_s—in other words, the probability that the silo will survive—can be expressed as:

$$P_s = e^{-1/2\left(\frac{r_s}{\text{CEP}}\right)^2} \qquad (9a)$$

Since the silo will either survive or be destroyed, the probability that the re-entry vehicle will explode within

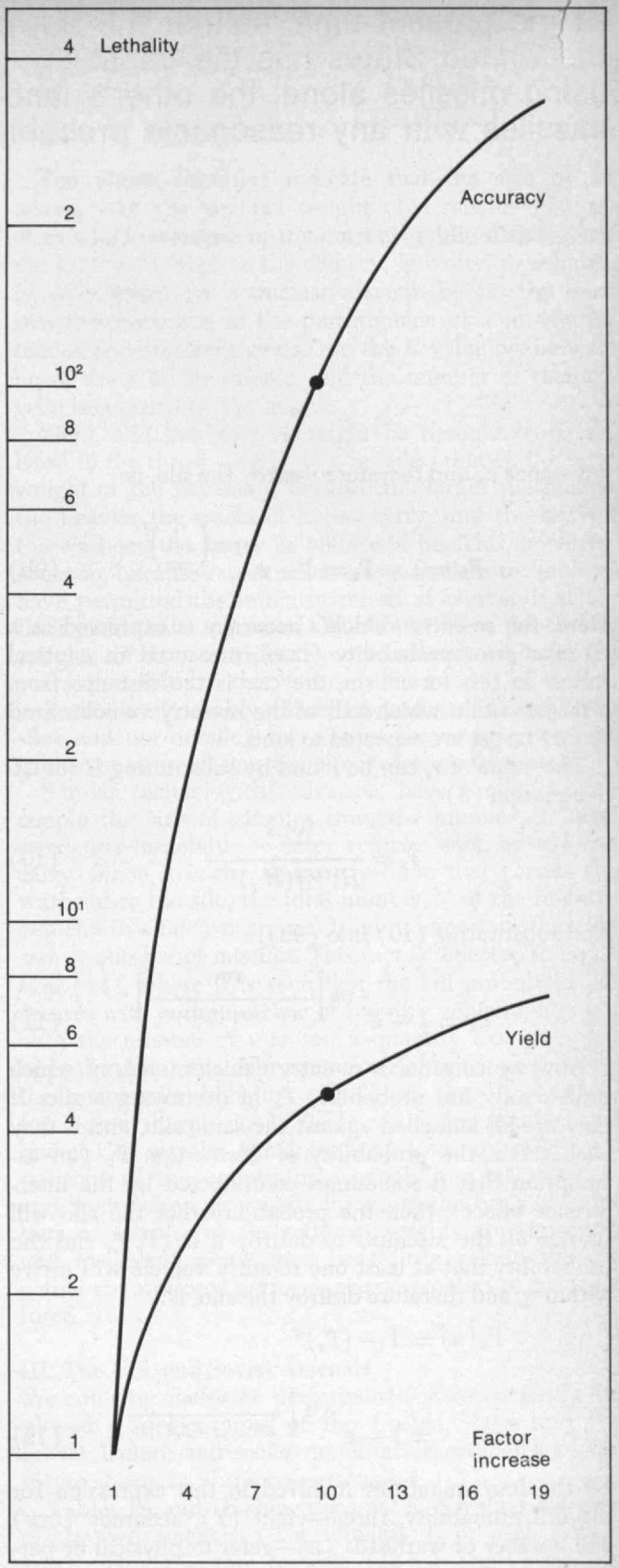


Chart 2. The result of improving the accuracy or the yield of a warhead. The top line plots the increase in warhead lethality when the accuracy of a missile increases while the yield of its warhead remains unchanged. The bottom line plots the converse—increased yield with no improvement in accuracy. As shown by the two points that have been drawn on the chart, a ten-fold increase in yield multiplies the lethality by about five, but a ten-fold increase in accuracy multiplies the lethality by 100.

At the present time, neither the Soviet Union nor the United States has the capability to destroy, using missiles alone, the other's land-based missiles with any reasonable probability.

a distance r_s, and therefore destroy the silo, is:

$$P_k = 1 - P_s = 1 - e^{-1/2\left(\frac{r_s}{\text{CEP}}\right)^2} \qquad (9b)$$

Here, the re-entry vehicle's accuracy is expressed as a circular error probability (CEP), measured in nautical miles. In this formalism, the CEP is the distance from a target within which half of the re-entry vehicles fired at that target are expected to land.

The value of r_s can be found by substituting H for Δp in equation (8):

$$r_s = \frac{Y^{1/3}}{H^{1/3}\{f(H)\}^{1/3}} \qquad (10)$$

And substituting (10) into (9b):

$$P_k = 1 - e^{-1/2\left[\frac{Y^{2/3}}{H^{2/3}(\text{CEP})^2\{f(H)\}^{2/3}}\right]} \qquad (11)$$

Now we consider n re-entry vehicles, each of which individually has probability P_k of destroying a silo. If they are all launched against the same silo, and if they each retain the probability of destruction P_k (an assumption that is sometimes contradicted by the interference effect), then the probability that the silo will survive *all* the attempts to destroy it is $(P_s)^n$, and the probability that at least one re-entry vehicle will arrive within r_s, and therefore destroy the silo, is:

$$P_k(n) = 1 - (P_s)^n$$

$$= 1 - e^{-1/2\left[\frac{Y^{2/3} \cdot n}{H^{2/3}(\text{CEP})^2\{f(H)\}^{2/3}}\right]} \qquad (12)$$

Of the four quantities involved in this expression for the kill probability, three—yield (Y), accuracy (CEP) and number of warheads (n)—refer to physical or performance characteristics of the missile and its warheads, while one—the hardness (H)—refers to a physical property of the silo under attack. From equation (12), a new parameter, K—the lethality of a re-entry vehicle to the silo—can be defined:

$$K = \frac{Y^{2/3}}{(\text{CEP})^2} \qquad (13)$$

The better the accuracy, that is, the smaller the CEP, the larger will be the K, and therefore the probability that the warhead can destroy the silo. As is seen in equation (13) and illustrated in Chart 2, K increases much more rapidly with improvement in accuracy than with increase in yield. If a missile carries n MIRVed warheads, each of lethality K, then $K \cdot n$ is a measure of the cumulative destructive power against a silo carried by that missile. If a country possesses m such missiles, $K \cdot n \cdot m = K \cdot N$ is a measure of the ability of that country to destroy the missiles of an opponent in their silos, a measure which allows a quantitative analysis of the counterforce capabilities of a nuclear arsenal, and which is therefore more useful than size or total number of missiles.

Substituting equation (13) into equation (12) gives:

$$P_k(n) = 1 - e^{-\left[\frac{K \cdot n}{2H^{2/3}\{f(H)\}^{2/3}}\right]} \qquad (14)$$

Taking the natural logarithm of both sides of this equation gives an expression for the $K \cdot n$ value necessary to destroy a silo of given hardness with a given probability:

$$\text{Ln}(1 - P_k(n)) = -\frac{K \cdot n}{2H^{2/3}\{f(H)\}^{2/3}} \qquad (15)$$

Since $1 - P_k(n)$ is always less than or equal to 1, $\text{Ln}(1 - P_k(n))$ is always negative or zero, so the absolute value of $\text{Ln}(1 - P_k(n))$ can be used in equation (15), and the minus sign on the right side eliminated:

$$|\text{Ln}(1 - P_k(n))| = \frac{K \cdot n}{2H^{2/3}\{f(H)\}^{2/3}} \qquad (16)$$

And finally:

$$K \cdot n = 2H^{2/3}\{f(H)\}^{2/3}\,|\text{Ln}(1 - P_k(n))| \qquad (17)$$

For $n = 1$, equation (17) gives the warhead lethality necessary to destroy a silo of given hardness with a given probability. For example, to destroy a 300-p.s.i. silo with 97 per cent probability, one needs a warhead with:

$$K = 2(300)^{2/3}(0.144)|\mathrm{Ln}(1-0.97)| \qquad (18)$$

This equals 45.26, or about 45. To destroy the same silo with 90 per cent probability, the K needed is 30. For a silo with 1,000-p.s.i. hardening, the K values necessary to destroy it with the same probabilities are 108 and 71 respectively. Ignoring the interference effects, the same results can be achieved by using a number of smaller warheads, each with lower K values, provided that the cumulative $K \cdot n$ values are the same.

So far, it has been assumed that once a missile is launched it will perform exactly as designed. This, however, is not always true. Missiles can and do malfunction, either at launch or during flight. The degree to which they perform as expected is expressed by a figure of merit ρ which describes the reliability of a weapon. For example, if a type of missile is said to have a reliability ρ of 0.7, this means that, on average, for every 10 such missiles launched, seven will arrive on target as expected, and the other three will not, due to some malfunction.

In calculating the probability P_k of a single warhead destroying a silo against which it has been launched, the reliability of the missile that carries the warhead must therefore be taken into account. This is done by multiplying P_k by ρ:

$$P_k(\rho, 1) = \rho \cdot P_k(1) \qquad (19)$$

If n warheads, individually carried by *different* missiles, all of reliability ρ, are targeted against the same silo, the probability that the silo will survive is:

$$(P_s)^n = (1 - \rho \cdot P_k(1))^n \qquad (20)$$

From equation (12):

$$P_k(\rho, n) = 1 - (1 - \rho \cdot P_k(1))^n$$

$$= 1 - \left\{ 1 - \rho \left\{ 1 - e^{-\left[\frac{K}{2H^{2/3}\{f(H)\}^{2/3}}\right]} \right\} \right\}^n \qquad (21)$$

For $n = 1$, equation (21) reduces to equation (19), and for $\rho = 1$, it reduces to equation (14). If n warheads aimed against a silo are carried by the *same* missile of reliability ρ, the kill probability P_k becomes:

$$P_k(\rho, n) = 1 - e^{-\left[\frac{K \cdot n \cdot \rho}{2H^{2/3}\{f(H)\}^{2/3}}\right]} \qquad (22)$$

The above formulae indicate that the size of an arsenal and the payload weight of a missile—parameters which are used in the current public debate—are not directly related to the efficacy, lethality, or reliability of a missile or a nuclear arsenal. By far the most sensitive measures of the performance of a missile intended for counterforce use are the K value of the warhead, the ρ of the missile, and the number of re-entry vehicles carried by the missile.

Yield, and therefore K, might be thought to be related to the throw-weight of a missile (that is, the total weight of the payload), because the larger the missile the heavier the warhead it can carry, and the heavier the warhead the larger its yield will be. This, however, is not so, because recent advances in nuclear technology have permitted the miniaturization of warheads while their yields have increased. Therefore, while the throw-weights of U.S. missiles have remained fixed for 10 years, the yields of the warheads they carry have been increased considerably. Since it is warheads that destroy silos and not missiles, the size of the missile becomes irrelevant to any discussion of counterforce weapons.

Similar technological advances have tended to decouple the size of missiles from the number of independently-targetable re-entry vehicles each missile can carry. Since it is the re-entry vehicle that carries the warhead to the silo, the total number N of the re-entry vehicles in a nuclear arsenal is more important than the size or number of missiles. This fact is reflected in equation (14), where it is seen that the kill probability increases with n, the number of re-entry vehicles, and not with the number of missiles, a quantity that does not appear at all in the expression for P_k. As Chart 1 shows, the countersilo lethality ($K \cdot N$) of the U.S. missile force rose sharply in 1970-71, while the number and size of U.S. missiles remained fixed. Consequently, comparisons of the counterforce capabilities of the U.S. and Soviet strategic missile forces on the basis of numbers of missiles or their throw weights are simplistic and irrelevant, since they bear little relationship to actual counterforce performance parameters of a missile force.

III. The U.S. and Soviet Arsenals

We can now assess the performance of the currently deployed strategic forces of the United States and the Soviet Union, and make quantitative estimates of the future strengths of the two arsenals.

Tables 1A and 1B show the total $K \cdot N$ values for each of the two arsenals. (The lethality K of each missile was calculated using formula (13).) The yields and accuracies of the warheads and missiles are officially classified in both countries, but there is enough information in the open literature to derive the figures listed. As a rule, the most pessimistic figures from the U.S. viewpoint have been used in this analysis: the $K \cdot N$ value for the U.S. arsenal is the smallest possible, supported by published figures, while that of the Soviet Union is the largest possible.

U.S. Missile	Warhead yield (Y) (megatons)	Re-entry vehicle accuracy (CEP) (nautical miles)	Lethality per re-entry vehicle ($K = Y^{2/3}/CEP^2$)	Number of re-entry vehicles per missile (n)	Number of missiles (m)	Total lethality ($K \cdot m \cdot n = K \cdot N$)
Minuteman III	(0.16)	0.2	5	3	550	8,250
Minuteman II	1	0.3	11	1	450	4,950
Titan	5	0.5	12	1	54	648
Poseidon	0.05	0.3	1.5	10	496	7,440
Polaris	0.20	0.5	1	3	160	480
Total					1,710	**21,768**

Soviet Missile	Warhead yield (Y) (megatons)	Re-entry vehicle accuracy (CEP) (nautical miles)	Lethality per re-entry vehicle ($K = Y^{2/3}/CEP^2$)	Number of re-entry vehicles per missile (n)	Number of missiles (m)	Total lethality ($K \cdot m \cdot n = K \cdot N$)
SS-9	20	(1)	7	1	288	2,016
SS-11, SS-13	1	(1)	1	1	970	970
SS-N-6	1	(1-2)	1	1	528	528
SS-N-8	1	(1-2)	1	1	80	80
SS-7, SS-8	5	(1.5)	1.3	1	209	272
Total					2,075	**3,866**

It must be noted at this point that the counterforce capabilities of bombers are not included in these calculations. Since the United States possesses roughly four times more bombers than the Soviet Union, inclusion of the bomber forces in the analysis would increase the discrepancy between the $K \cdot N$ values of the two arsenals in favor of the United States. However, although the pin-down effect makes the employment of bombers against hardened silos technically possible, such an operation involves uncertainties large enough to render any meaningful estimate of its efficacy unfeasible.

In calculating countersilo capabilities of missile forces, it must be remembered that the reliability, ρ, of missiles is not usually unity but more nearly 0.8 or 0.9, (this represents the proportion of missiles that will not malfunction during launch or in flight), and that not all the submarine-launched missiles are on station at all times. Furthermore, not all nuclear weapons would be used for countersilo attack; it is reasonable to assume that both countries would withhold some nuclear weapons to target against the opponent's cities, to use as a means for bargaining the termination of hostilities, or to aim against a third nuclear power.

With this caveat in mind, the total $K \cdot S$ needed to destroy all of an enemy's land-based missiles in their silos can now be calculated, by calculating with formula (17) the K required to destroy each silo, and then multiplying it by the number of silos, S, the enemy possesses. Setting $n = 1$ in equation (17) gives the K value needed to destroy a given silo with a given probability (as was illustrated in equation (18)). Tables 2A and 2B give the total $K \cdot N$ values needed to destroy the Soviet and U.S. silos, respectively. The Soviet Union has about 1,500 missile silos with varying degrees of hardening; about 1,100 of these, built before 1969-70, have a hardening of about 100 p.s.i., while the remaining 400 have been built since that date, and have a hardening of about 300 p.s.i. These numbers are approximate and have been rounded off in line with the pessimistic (from the U.S. vantage point) approach of this article. The Soviet Union has recently constructed about 100 silos with 450 p.s.i. hardening, apparently intended for the as yet undeployed new SS-17 or SS-19 missiles now undergoing testing, but since these silos are empty, they are not included in Table 2A.

The United States has recently upgraded its Minuteman III silos to 1,000 p.s.i. hardening. (These silos are also provided with shielding against EMP effects.) The 450 Minuteman II and 54 Titan silos are still hardened only to 300 p.s.i. Plans have been announced for upgrading the hardening of the Minuteman II silos and for exchanging the Titan missiles with submarine-launched ballistic missiles (SLBM's), but since these are future events they have not been taken into account in Table 2B.

A comparison of the figures in Tables 1A and 1B with those in Tables 2A and 2B indicates that, at the present time, neither the Soviet Union nor the United States has the capability to destroy, using missiles alone, the land-based ICBM force of the other country with any reasonable probability. The total $K \cdot S$ needed to destroy all the U.S. silos with 97 per cent probability is over 82,000 while the total $K \cdot N$ that all the Soviet missiles can deliver is below 4,000. Similarly, the total $K \cdot S$ needed to destroy all the presently deployed Soviet silos with the same probability is 40,000 while the present U.S. missile force carries a $K \cdot N$ below 19,000.

The same conclusion can be drawn, in a more striking way, by comparing the K of the individual re-entry vehicles available in each arsenal with the K required to destroy a silo. The most powerful Soviet warhead, that carried by the SS-9 missile, has a K of 7. Since a K of 45 is needed to destroy a 300-p.s.i. silo with $P_k = 0.97$, the 288 SS-9 missiles can destroy only 45 of the 504 U.S. 300-p.s.i. silos, or only 19 of the 550 Minuteman III 1,000-p.s.i. silos, even if perfect reliability is assumed. On the other hand, even if it is assumed (disregarding the restrictions in targeting imposed by the

Soviet Silo hardness (p.s.i.)	K required per silo $P_k = 0.97$	K required per silo $P_k = 0.90$	Number of silos (S)	Total K · S $P_k = 0.97$	Total K · S $P_k = 0.90$
300	45	30	(400)	18,000	12,000
100	20	13	(1,100)	22,000	14,300
Total				**40,000**	**26,300**

Tables 1A (opposite page) and **2A** (this page) compare the lethality of the U.S. missile arsenal with the lethality required to destroy Soviet missile silos. Two "kill probabilities," or P_k's, are used in the calculations. Using $P_k = 0.97$, for example, shows that an American lethality of 40,000 is required to destroy 97 per cent of all Soviet silos. Table 1A's figures are for 1975; all other figures are for 1974.

U.S. Silo hardness (p.s.i.)	K required per silo $P_k = 0.97$	K required per silo $P_k = 0.90$	Number of silos (S)	Total K · S $P_k = 0.97$	Total K · S $P_k = 0.90$
1,000	108	71	550	59,400	39,050
300	45	30	450	20,250	13,500
300	45	30	54	2,430	1,620
Total				**82,080**	**54,170**

Tables 1B (opposite page) and **2B** (this page) perform a similar comparison for the Soviet arsenal used against American silos. Taken together, the four tables at the left show that neither country's missile arsenal currently has sufficient lethality to destroy the other's silos with high probability. (Numbers in parenthesis are estimates.)

nature of MIRVed re-entry vehicles) that each of the 1,650 re-entry vehicles of the Minuteman III force were targeted against each one of the Soviet land-based ICBM's, the probability of destroying them in their silos is only 40 per cent (calculated from equation (11)). This probability drops to 37 per cent if the Minuteman III missiles have 0.9 reliability, and to 29 per cent if the reliability is 0.8 A more detailed demonstration of the fact that neither arsenal contains weapons that can destroy even a fraction of the land-based missiles of the other country is provided in Table 3, which shows that the number of re-entry vehicles from existing weapons needed to destroy a silo is so large that the interference effect precludes the possibility that these missiles can be used successfully in a counterforce role.

Although neither the United States nor the Soviet Union actually has a counterforce capability at present, the discrepancy between the two countries in total $K \cdot N$ values (19,000 vs. 4,000 in 1974), and re-entry vehicles (6,200 vs. 2,100), must have been used by the Soviet military to exert pressure on the Soviet political leadership for new MIRVed missile construction programs. In 1970, the Soviet Union caught up with the United States in numbers of missiles, only to fall far behind in independently-deliverable warheads as a result of the MIRVing of the U.S. land- and sea-based missiles. The same happened with the total $K \cdot N$ value of each arsenal: the two countries reached approximate parity in $K \cdot N$ value of their strategic forces in 1970, but by 1974, improvements in the accuracy of U.S. missiles and the introduction of MIRV had increased the $K \cdot N$ value of the U.S. strategic arsenal to about five times that of the Soviet arsenal.

It is a reasonable conjecture that, under the internal political pressures fueled by these large discrepancies, the Soviet leadership decided to proceed with the present expensive program of construction and deployment of new missiles, now in their testing stage. It is interesting to note that if the Soviet Union were to carry out a total replacement of its present land-based missile force—replacing all the SS-11 missiles with the new SS-17 or SS-19 MIRVed missiles, and the large SS-9 missiles with the even larger SS-18's, which are capable of carrying five independently-targetable warheads—they will have about the same number of independently-targetable warheads that the United States has now. Such parity can occur in 1980 or 1981. In that case, the U.S. MIRVing program of the 1970s will have resulted in an increase in the number of warheads aimed against the United States, from about 2,000 to 10,000, as Chart 3 illustrates.

To calculate the K values of the Soviet MIRVed warheads, it is necessary to estimate their projected accuracies, since there are no figures available at this time. The evolution of U.S. missiles provides a measure of the rate of improvement in accuracies that a highly advanced technology can support: the CEP (that is, the accuracy) of U.S. missiles has been halved every time a new generation of re-entry vehicles is installed on the missiles—about every five years—and it is doubtful whether the Soviet technology, which lags far behind that of the United States, can achieve a faster rate of improvement.

As a matter of fact, there are indications that even matching the U.S. rate of improvement is an unrealistic prospect. Soviet computer technology is five to 10 years behind that of the United States. Since miniaturized on-board computers are central in improving the accuracy of re-entry vehicles, it is difficult to imagine how the new Soviet missiles, which will have on-board computers for the first time, can achieve results that, in the United States, took many years of development, supported by an advanced computer technology. The latest Soviet guidance equipment captured in the recent Arab-Israeli War was found to use vacuum tubes rather than transistors, indicating that the micro-miniaturization of electronics and computer memories essential in achieving high accuracies is many years away in the

Kill probability (P_k)	Silo hardness (p.s.i.)	K required per silo	Existing Soviet Missiles		Existing U.S. missiles	
			SS-9 ($K = 7$)	SS-11 ($K = 1$)	Minuteman III ($K/RV = 5$)	Poseidon ($K/RV = 1.5$)
0.99	300	60	8	60	12	40
	500	87	12	87	17	58
	1,000	142	20	142	28	95
0.97	300	45	6	45	9	30
	500	66	9	66	13	44
	1,000	108	15	108	22	72
0.95	300	39	5	39	8	26
	500	56	8	56	11	37
	1,000	93	13	93	19	62
0.90	300	30	4	30	6	20
	500	43	6	43	9	29
	1,000	71	10	71	14	47
0.75	300	18	2	18	4	12
	500	26	4	26	5	17
	1,000	43	6	43	9	29
0.50	300	9	1	9	2	6
	500	13	2	13	3	9
	1,000	22	3	22	4	14

Table 3. The numbers of re-entry vehicles (RV's) required to destroy a silo with various probabilities. Figures for existing missiles in the Soviet and U.S. arsenals are shown on the left side of the table; figures for new Soviet missiles and U.S. missiles after planned improvements are shown on the right. Throughout the table, the effects of a nuclear blast are assumed to have no deleterious effect on subsequent attempts to hit the same target. Moreover, ρ is assumed to equal one; that is, the missiles are assumed to be perfectly reliable. Even so, the lethality of the Soviet Union's most effective missile (the SS-9) assures only a

Soviet Union. Finally, the Soviet Union lacks the very accurate metal-cutting equipment essential in the construction of gimbaled gyroscopes and accelerometers. Missile accuracies of even one-half nautical mile require machining inertial guidance components to better than a few millionths of an inch and aligning them with precisions of a few microradians. The Soviet Union does not possess equipment capable of such precision, as evidenced by its recent unsuccessful efforts to acquire milling machines of that type in the United States. Inertial measurement units that could overcome some of these difficulties require extensive on-board computational capacity that is only now becoming feasible, even in the United States.

Since the CEP of existing Soviet land-based missiles is about one nautical mile, one can expect that the accuracies of the new generation of Soviet MIRVed missiles will be close to, but not significantly better than, one-half nautical mile. In addition, it is assumed that the 900 Soviet sea-based missiles will also have 0.5 nautical mile CEP (a truly exaggerated figure since the present accuracy of the Soviet SLBM's is about two nautical miles). It is expected that the SS-18 missile will carry five re-entry vehicles, each with a yield of about one megaton, and that the replacements for the SS-11 will carry six re-entry vehicles of about 0.2 megatons each. The total $K \cdot N$ value of the Soviet missile force in 1980-81 will, therefore, be about 20,000, as an upper limit. Thus, even if the United States undertakes absolutely no new strategic weapons improvement programs from now on, and if the Soviet Union completes, at the fastest possible rate, the maximum improvement of its land-based missile force possible under the present circumstances, dictated by the 1972 Strategic Arms Limitation Talks (SALT) interim agreement on offensive missiles, the United States will still have an advantage both in $K \cdot N$ value and in number of re-entry vehicles in the early 1980s.

Despite this tangible superiority of the U.S. missile arsenal, two new sets of programs for the drastic improvement of U.S. missiles have been proposed by Mr. Schlesinger. The first can be implemented with existing technology. It will result in a twofold increase in the yield of the Minuteman III and SLBM warheads, and an improvement in the accuracy (CEP) of the Minuteman III reentry vehicles to about 250 meters (0.11 nautical miles) and of the missiles intended for the Poseidon and Trident submarines to somewhat better than 0.2 nautical miles. These improvements will increase the K of a Minuteman III warhead to about 40 and that of a Poseidon warhead to somewhat more than 8. And they will change the strategic and political situation radically, for three reasons:

(1). The total $K \cdot N$ value of the U.S. arsenal will rise to over 110,000—a value five times more than the Soviet Union's nuclear arsenal could possibly have by 1981-82, and high enough to threaten the Soviet silos with assured destruction.

(2). A warhead with $K = 40$ has a 96 per cent probability of destroying a 300-p.s.i. silo. Therefore, for the first time, the United States will possess a weapon with a K value high enough to enable it to destroy a silo with a single attempt, thereby avoiding the problem of the interference effect.

New Soviet missiles			U.S. Program I		U.S. Program II	
SS-17 or SS-19 (K/RV = 1.5)	SS-18 (K/RV = 4)	SS-N-6 or SS-N-8 (K/RV = 2)	Improved Minuteman III (K/RV = 40)	Improved Poseidon (K/RV = 8)	MARVed Minuteman III (K/RV = 450 to 1,300)	MARVed Poseidon (K/RV = 170 to 500)
40	15	30	1	8	1	1
58	22	44	2	11	1	1
95	35	71	3	18	1	1
30	11	23	1	6	1	1
44	16	33	1	8	1	1
72	27	54	3	13	1	1
26	10	20	1	5	1	1
37	14	28	1	7	1	1
62	23	47	2	12	1	1
20	8	15	1	4	1	1
29	11	22	1	5	1	1
47	18	36	2	9	1	1
12	5	9	1	2	1	1
17	7	13	1	3	1	1
29	11	21	1	5	1	1
6	2	4	1	1	1	1
9	3	6	1	1	1	1
14	5	11	1	3	1	1

50-per-cent probability of destroying a 300-p.s.i. silo with one attempt. Similarly, two attempts by the United States' most lethal weapon (the Minuteman III) would be necessary to destroy the same silo with the same probability. Thus neither nation currently possesses a weapon that would be effective in a counterforce attack, because the probability of failure would be too great. However, as shown on the right side of the table, the planned improvements in American missile systems will produce weapons that can destroy even 1,000-p.s.i. silos on the first attempt with virtual certainty.

(3). In a situation of limited response to an opponent's actions, it is certain that no responsible military leader would use a missile against an adversary's silo unless he were sure that the strike would be successful. Because the political embarrassment of an unsuccessful strike would be too large, the military would hesitate to respond with nuclear weapons to any but the most provocative acts of an opponent. Therefore, an accurate weapon with such high kill probability will enlarge the set of circumstances under which the military would be willing to use it, thereby increasing substantively the chance of a nuclear exchange with the Soviet Union.

The second program proposed by Mr. Schlesinger aims at introducing terminal guidance on U.S. re-entry vehicles. In present MIRV technology, a so-called "bus," which contains several warheads, is released from the missile in flight. The bus changes its orientation as it flies, and can thus impart a different trajectory to each of the warheads it carries as it casts them off, one after another. The new proposal is to add another set of guidance systems, these on the individual re-entry vehicles, which could then further refine their trajectories even after leaving the bus. This would endow them with accuracies of 30 to 50 meters or better. Although the techniques required for terminal guidance of maneuverable re-entry vehicles (MARV) are beyond the research stage, they still require extensive development before they can be incorporated into reliable weapons systems, and so it may be 10 more years before these weapons enter the U.S. strategic arsenal. The achievement of such accuracies by the introduction of MARV has several military and political implications. First of all, a single Minuteman III re-entry vehicle with a 0.2 megaton warhead will have a K of 450 for a 50-meter CEP and a K of 1,300 for a 30-meter CEP. Similarly, one of the present Poseidon warheads (yield = 0.05 megatons) will have a K of 170 for a 50-meter CEP and a K of 500 for a 30-meter CEP. Such K values will permit the destruction of land-based missiles from submarines, since a warhead with $K = 170$ will destroy a 1,000-p.s.i. superhardened silo with 97 per cent probability and one with $K = 500$ will do it with virtual certainty.

If the U.S. missile force remains invariant in every other respect (number of launchers, number of independently targetable re-entry vehicles, and yield of warheads) but is equipped with re-entry vehicles capable of 30-meter accuracy, the total $K \cdot N$ value of the U.S. strategic missiles will rise to about four million. And this figure does not include the net $K \cdot N$ loading of systems that are not already deployed, such as the Trident submarine, or the $K \cdot N$ of the existing bomber force.

Yet such staggering lethality does not offer any practical superiority, because even if all the Soviet land-based missiles are destroyed, there will still remain in the Soviet arsenal several hundred submarine-based missiles that can completely devastate the U.S. population and industrial centers. The fact remains that a few dozen missiles can deter even the most daring political leader from launching a nuclear attack. Deterrence has worked in the past and will remain a sobering political reality in the future, despite the artificial emphasis

The manifest superiority of the U.S. arsenal cannot be translated into a permanent political advantage over the Soviet Union.

placed on the performance of land-based missiles and the future strategies one can weave with them. The military leaders of the Soviet Union may be lured into responding to these U.S. programs with similar efforts to upgrade the accuracy of their missiles, and thereby offer justification to the technological bureaucracy of the U.S. defense establishment for still further programs. But independently of the precipitousness with which the Soviet Union responds, three predictions can be safely offered:

(1). Since the properties of matter make the achievement of accuracies better than 30 meters or so difficult but not impossible, Soviet missile accuracies will sooner or later catch up those of U.S. missiles, restoring, sometime in the early 1990s, the parity of forces that will have existed twice before—in the early 1970s in number of launchers, and in the early 1980s in number of independently-deliverable re-entry vehicles. Thus nature will terminate the competition for increased lethality of nuclear weapons that political leaders seem unable, and the military unwilling, to end.

(2). The most probable immediate Soviet response to such programs is to put its missiles on a launch-on-warning basis, thereby increasing considerably the crisis instability—that is, the probability of an unintentional nuclear exchange.

(3). If the Soviet leaders decide that the survivability of their strategic missile forces warrants additional expense, they can replace their silo-bound ICBM's with mobile ones, thereby rendering U.S. improvements in accuracy useless, but at the same time complicating further the complex task of verification—inspection by one country of the number of missiles another country possesses. Ultimately, terminal guidance presents a threat not to the strategic missiles of the U.S.S.R., but to arms-limitations efforts.

IV. The Consequences of High Lethality

Several conclusions can be drawn as direct corollaries of the present and projected countersilo kill capabilities—the $K \cdot N$ values—of the U.S. and Soviet nuclear arsenals. Some have already been suggested by the previous section's discussion of weaponry.

(1). Since the United States is and always has been ahead of the Soviet Union in warhead countersilo lethality, and will continue to remain so even after the Soviet Union had made the maximum possible improvements that its present upgrading program can afford, the programs requested by Mr. Schlesinger for further U.S. missile improvements are unjustified and unnecessary. Even if the Soviet Union were to threaten the U.S. land-based missile force with its improved missiles, Mr. Schlesinger's programs do not alleviate this threat, since improving the accuracy of re-entry vehicles does not protect the missiles that carry them from a Soviet threat.

(2). The requested improvements in accuracy and yield of U.S. nuclear weapons are of dubious political, or actual strategic value. The presence of the invulnerable Soviet SLBM force ensures that the United States cannot disarm the Soviet Union with a first strike, even by using the most exquisitely accurate or reliable re-entry vehicles. Since there is no anti-ballistic-missile system (ABM) to protect U.S. cities from submarine-launched missiles, the hostage relationship of deterrence will remain the operative consideration in any confrontation between the two countries. And since increased performance sophistication does not affect the counter-city deterrent value of the U.S. nuclear arsenal either way, the strategic importance of increased accuracies remains in question.

As the presence of SLBM's and the absence of ABM's on both sides maintain the hostage relationship between the two countries, no increase in countersilo kill capabilities can contribute a proportionate increase to the credibility of the U.S. nuclear umbrella. No European ally will be persuaded that the United States will be more willing to expose its cities and industrial centers to Soviet nuclear weapons by coming to the aid of the European countries with nuclear weapons, simply because these weapons are more accurate. A limited response to a Soviet provocation would indeed be more credible to European political leaders, but such a response requires only re-targeting of U.S. missiles and improved flexibility in the command and control of the strategic forces; it does not require improved accuracies, unless such improvement is necessary to persuade the U.S. military leadership that strategic missiles can be used without risk of failure. It is doubtful, however, that the Europeans would be heartened by the assurance that U.S. military men, whom they do not control, will be more ready to use nuclear strategic weapons in a confrontation between the Soviet Union and Europe, because these weapons are more accurate.

The manifest technical superiority of the United States, reflected in improved accuracies of re-entry vehicles, cannot be translated into a permanent political advantage over the Soviet Union. The programs being

proposed by the U.S. Defense Department will, no doubt, provoke demands by the Soviet military leadership for new Soviet efforts to upgrade the K value of their weapons. There is no doubt that Soviet technology, although lagging behind that of the United States, can achieve that goal. Parity in performance—that is, in $K \cdot N$ values—will eventually be reached, as was parity in number of launchers, and as parity in number of warheads will be in a few years. If, on the other hand, the Soviet Union recognizes that improvements in K value do not bestow any real advantages in a nuclear arsenal and therefore chooses not to match the U.S. efforts, then again the new U.S. weapons will be devoid of any political advantage, because this tangible display of Soviet lack of concern about them will rob the United States of any psychological advantage that it may have hoped to gain by their deployment.

(3). It is doubtful, however, that the Soviet Union will display rational restraint in the face of the new U.S. programs. To quote: "If they marry the technologies that they are now acquiring to the throw weight that they possess under the [SALT] interim agreement, then they could develop a clear preponderance of counterforce capabilities . . . we do not want to allow such an imbalance in terms of strategic forces to develop . . ." This statement was made by Secretary of Defense Schlesinger at a news conference on August 17, 1973, at a time when the United States possessed a five-to-two advantage in re-entry vehicles and a five-fold advantage in $K \cdot N$ value over the Soviet Union! One can easily imagine exactly the same words being uttered in a Soviet cabinet meeting a few years from now, if the proposed U.S. programs are funded. Because these programs ensure that real parity in strategic forces between the U.S. and the U.S.S.R. will not be reached, even in the 1980s, their result will be to perpetuate, into the last decade of this century, the escalation in lethality and in the probability of use of nuclear weapons, while at the same time making any arms-limitation agreements impossible.

As Chart 4 portrays, every improvement in U.S. strategic missiles has been inexorably followed a few years later by a matching Soviet effort. One can reasonably expect that exactly as U.S. military and political leaders would be reluctant to conclude arms-limitations agreements while in a position of strategic inferiority, so would their Soviet counterparts. Consequently, arms-limitation agreements are possible only at times when the two strategic arsenals are about equal in some respect. It can be argued that the SALT I agreements were possible in 1972 because of the fleeting parity in launchers between the two forces in the 1970-71 period, and that the SALT II negotiations failed in 1974 because of the huge discrepancies in numbers of re-entry vehicles in the two arsenals. Arms-limitation agreements do not seem possible in periods of transition from one parity level to the next. From Chart 3, it can be seen that if the programs proposed by Mr. Schlesinger are not implemented, the next propitious period for arms limitations will be between 1980 and 1982. If, however, these programs are funded, by the time the Soviet Union reaches parity in re-entry vehicles with the present level of U.S. strategic forces, the United States will have quadrupled the $K \cdot N$ loading of its forces, and will have deployed warheads capable of destroying 300-p.s.i. silos with 98 per cent probability.

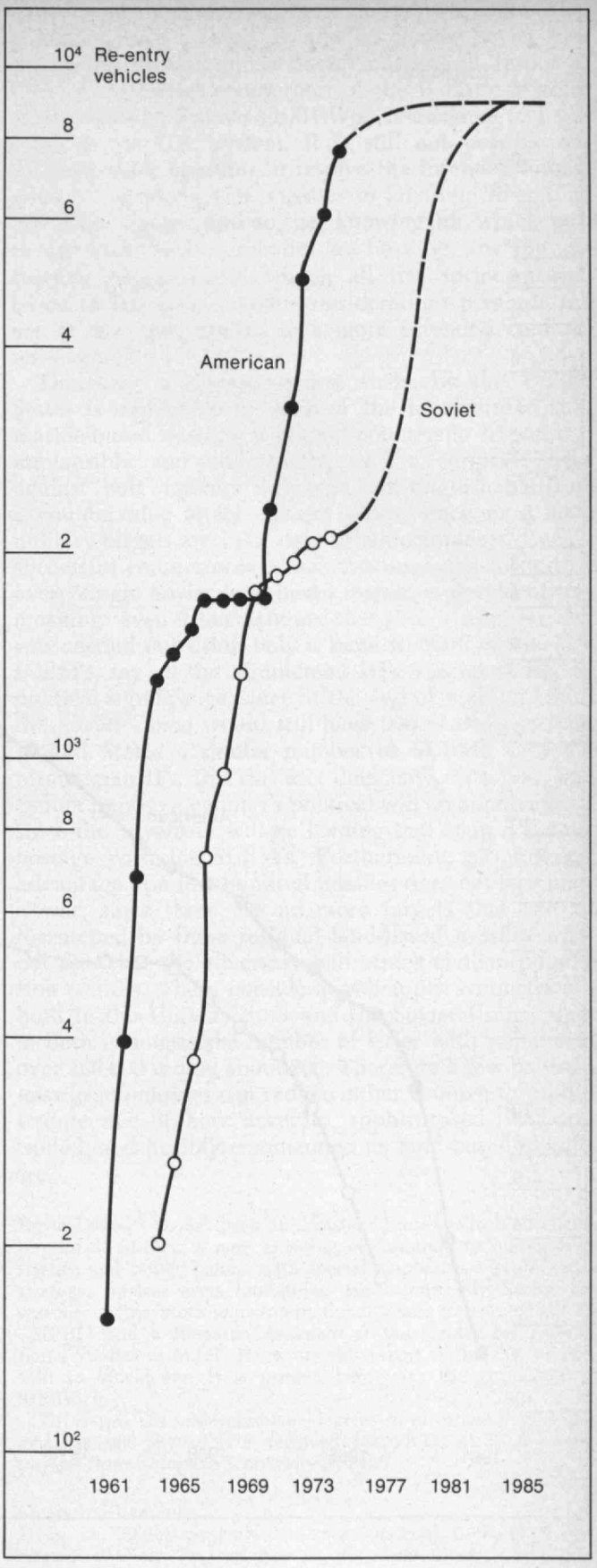


Chart 3 compares the number of independently targetable warheads in the U.S. and Soviet nuclear arsenals. The charts shows that parity was attained in 1970, but that the U.S. then resumed its lead by the deployment of MIRVs. If the Soviet Union completely replaces its present missiles with the MIRVed missiles it is now testing, parity may again be attained in the early 1980s.

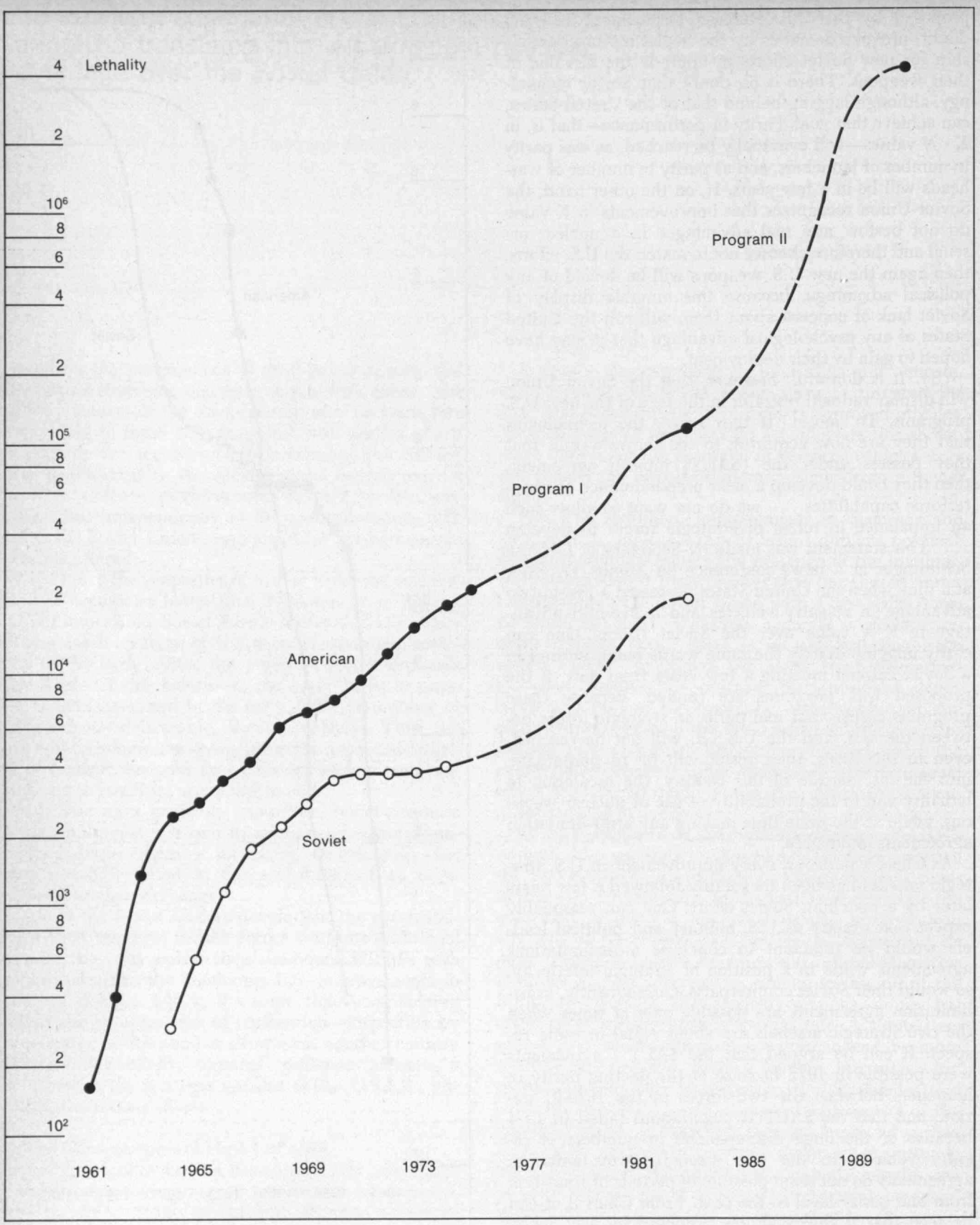


Chart 4 compares the total lethality of the U.S. and Soviet missile arsenals. The U.S. currently possesses a five-fold advantage, but two new programs have been proposed. The first would improve the yield of U.S. warheads, and the accuracy with which present missile systems deliver them to their targets, thus raising the lethality of the American arsenal to about 110,000 in the early 1980s—a level sufficient to destroy all Soviet missile silos with virtual certainty. Meanwhile, the maximum predicted Soviet advances would not lessen the five-fold lag, nor would they threaten U.S. silos with assured destruction. In the 1980s, U.S. Program II would further increase accuracy by the introduction of new guidance technology. Lethality would then rise to 4 million in the early 1990s, as U.S. re-entry vehicles became capable of reliably landing within 30 meters of their targets.

Therefore, rather than enter further arms-limitation negotiations, the Soviet Union will probably deploy mobile ICBM's, making any limitation of strategic missiles even more difficult.

The introduction into the U.S. arsenal of maneuverable re-entry vehicles (MARV's) with accuracies of 30 to 50 meters or better will further increase the discrepancy between the performance capabilities of the two missile forces and therefore will further diminish the probability of arms-limitation agreements until the Soviet Union also develops MARV's some time in the 1990s. It is difficult to escape the conclusion that by proposing these programs, Mr. Schlesinger is excluding parity, and therefore the prospect of any substantive arms-limitation agreements for the next 20 years or so.

(4). Apart from not providing any real or lasting political advantage for the United States, and making arms-limitation agreements highly improbable for the next two decades, the proposed new weapons also appear to be devoid of any significant military utility. It has been argued, for example, that the improved accuracy of these weapons will permit a limited and flexible response to a Soviet provocation by making possible attacks against military targets near urban centers without collateral destruction of civilian population and structures. This, however, is physically impossible. Two re-entry vehicles with identical 0.2 megaton warheads, but with accuracies of 0.25 nautical miles and 30 meters respectively, will both devastate exactly the same area: a circle with a radius of between two and three nautical miles. The only difference is that for the first weapon, this area's center will be within approximately 0.25 nautical miles of the intended target, while for the second the center will be within a few tens of meters of the target. Therefore, if the intended target of the re-entry vehicle is more than two to three nautical miles away from a city, neither weapon will cause grave damage, but if it is closer than this, both weapons will cause damage. Thus the more accurate weapon is not more humane: The radius of destruction of nuclear weapons is so much larger than the differential improvement in accuracy envisioned by these programs that the results of an attack near a city are the same irrespective of the sophistication of the weapon, so the new weapons cannot be used more readily than the older re-entry vehicles against military targets that are near cities. The politically significant distinction of whether the attack was against a military or a civilian target will be no easier to make in the case of the more accurate weapon; the recipient country will still view the attack as a countervalue strike and will answer it in kind.

It is true that the new weapons will have the added military capability of destroying superhardened silos with certainty. They will provide U.S. strategic planners with the basis for new strategic scenarios and the formulation of new options that they have been so persistently requesting for many years. It is doubtful, however, if the anticipated increase in the repertoire of strategic options open to future political leaders will be either real or desirable from the national security point of view.

If the United States deploys MARVed warheads with *K* values in the hundreds, the Soviet Union will revert to mobile ICBM's, remove land-based missiles altogether from its strategic inventory, or assume a launch-on-warning policy. In either of the first two cases, the new re-entry vehicles will be useless. In the third case, launching even a few U.S. missiles against Soviet silos will bring several dozen Soviet missiles in response: Even if the Soviet counterpart of the Ballistic Missiles Early Warning System (BMEWS) is assumed to be as good as the U.S. system, it is still not possible for a Soviet radar operator to resolve the intended impact point of incoming U.S. missiles to anything finer than 200 miles square, and so, not knowing for which particular silos the U.S. missiles are heading, any prudent Russian officer would launch all the Soviet missiles based in this area. Similar considerations preclude the use of the new missiles in a more extended counterforce attack.

Therefore, a disarming first strike by the United States is impossible in view of the invulnerable submarine-based missiles; a limited countersilo response is implausible and undesirable; and a surgical strike against "soft" military targets is indistinguishable from a countervalue attack against cities, since most such military targets are in or near urban complexes. Even a successful counterforce attack that manages to destroy every single Soviet land-based missile is devoid of any meaning: even if one assumes that such a complex task was carried out using only a large fraction of the U.S. ICBM's, say all the Minuteman III's, the result has no political significance, since at the end of such an attack the Soviet Union would still have 900 SLBM's and the United States a similar number of SLBM's plus 450 Minuteman II's. But this fact does not win a war, and cannot impose a country's political will on an adversary, since the adversary will be holding that country's cities hostage with his SLBM's. Furthermore, a numerical advantage of a few hundred missiles does not terminate a war, since there are no more targets that can be threatened by these residual land-based missiles without fear that the adversary will attack civilian population centers. These considerations apply symmetrically both to the United States and the Soviet Union, since in both countries the number of cities with population over 100,000 is only about 200. Therefore a few ballistic-missile submarines can reduce either country to rubble, irrespective of how accurate, sophisticated, well-controlled, and flexibly commanded its land-based missiles are.

Kosta Tsipis, who has been an Assistant Professor in high energy physics at M.I.T., is now devoting all his time to questions of science and public policy, with special emphasis on problems of strategic nuclear arms limitations. He is currently Senior Researcher at the Stockholm International Peace Research Institute (SIPRI) and a Research Associate at the Center for International Studies at M.I.T. He wrote this report during his summer visit to Stockholm. It is printed here with the permission of SIPRI.

Dr. Tsipis has undergraduate degrees in electrical engineering and nuclear physics. He received his Ph.D. in high energy physics from Columbia University in 1966.

Suggested Readings

Hoag, D., "Ballistic-missile Guidance," in Feld, B. T., *et al.* eds., *Impact of New Technologies on the Arms Race* (Cambridge, Mass., MIT Press, 1973).

Brode, H., "Review of Nuclear Weapons Effects," *Annual Review of Nuclear Sciences,* 1968, pp. 153-202.

Walsh, J. B., "Technological Challenges," paper presented to the U.S. Air Force Association symposium on Strategic Weapons Developments, Vandenberg Air Force Base, California, 1 May 1974.

"A New Sense of Urgency" on Nuclear Arms

It is generally agreed that the U.S. could reliably detect by sophisticated seismography a nuclear explosion with a yield of 150 kilotons (equivalent to the detonation of 150,000 tons of TNT) or more anywhere in the world; so could the U.S.S.R.

The unresolved technical problem—publicly, at least—is to distinguish smaller nuclear explosions from earthquakes. Upon this issue efforts to negotiate an international nuclear test ban have foundered: the Russians have refused to permit on-site inspections when required to verify that what other nations' seismographs have recorded were indeed earthquakes, not small-scale nuclear tests conducted in violation of a treaty.

Hence the apparent logic of the agreement during the summer summit by President Nixon and Secretary Brezhnev: no tests of nuclear explosives with yields over 150 kilotons after 1976. The stalemated issue of inspection does not arise, since everyone agrees that violations are easily detected.

Toward Nuclear Confrontation

But the scientific community has denounced the agreement as "sham" and "mockery." Even before it was concluded, Professors George W. Rathjens and Jack P. Ruina of M.I.T. wrote in *Science* that the effect of such a treaty would be "minimal at best, and very possibly negative."

Soon after the ceremonial signing in Moscow, members of the U.S. and Canadian Pugwash Executive Committees—scientists from the two nations responsible for their countries' parts in the international Pugwash scientific conferences each fall—issued some "somber reflections": "The nuclear threat is not under control," they said; the path of the cold war continues to lead inevitably toward "nuclear confrontation," and they seek to restore to the problem the "sense of urgency and concern" which has been undermined by complacency in the last five years.

Four events brought the Pugwash group to what it calls a "rude awakening":

—The Indian test of a nuclear explosive, manufactured from materials which were by-products of a program supposedly devoted only to "peaceful" uses of the atom.

—President Nixon's offer of nuclear plants to Egypt and Israel and the sale of such a plant to Iran by France and the U.S. As the Pugwash group points out, such plants produce as a by product plutonium from which can be made nuclear explosives (which is precisely what happened in India), and their sudden appearance "in an area scarred by four wars in the last 25 years" led to a question: "Is the spread of nuclear power plants an open sesame to the spread of nuclear weapons?"

—The rising pace of nuclear testing. For the first time since 1965, all five of the nuclear powers conducted tests this summer.

—The "shambles of the Moscow summit," as a result of which the Pugwash group feels "a new cycle in the arms race is about to begin. The inability (of Nixon and Brezhnev) to reach agreement on limitation of strategic nuclear weapons virtually guaranteed a major increase in the already-astronomical level of overkill available to the superpowers."

Moscow Was "Simply a Fraud"

The Pugwash group's statement was released in midsummer at M.I.T. by Professor Bernard T. Feld, who is Secretary-General of Pugwash. Talking with *Science* about it, Professor George B. Kistiakowsky of Harvard, one of the signers of the statement who is a Visiting Scholar in the M.I.T. Center for International Studies, called the summer's Moscow agreement "simply a fraud. . . . You can detect a nuclear explosion of 15 kilotons by existing means," he insisted. And a large weapon "can be tested at a yield below the 150 kilotons threshold in complete confidence that the weapon to be deployed will, with certain changes, work at much higher yields."

Indeed, thinks Alexander Rich, Sedgwick Professor at M.I.T. who was also one of the participants in the Pugwash statement, the 150 kilotons limit (that is ten times the yield of the Hiroshima atomic bomb) on testing may be higher than any explosive the U.S. Atomic Energy Commission had been planning to test. The result may well be to stimulate the A.E.C. to plan for large tests "which I think they wouldn't have asked for otherwise," he told *Science*.—*J.M.*

The U.S. Arms Control and Disarmament Agency proposes that President Nixon and Secretary Brezhnev (shown above exchanging pens during the signing ceremonies in Moscow) resolved a longstanding impasse by approving this summer's arms control agreements. But the size (150 ktons.) of the limit on which the two national leaders agreed was so large that the agreement was likely to be "widely viewed as a measure of how pathetically little they were prepared to accept in the way of nuclear arms control at this time," wrote Professors George W. Rathjens and Jack P. Ruina of M.I.T. in *Science*. And even Senator Edward F. Kennedy was quoted as saying, "It is not clear that this treaty is better than nothing." (Photo: Wide World)

Political Games: Experiments in Foreign Policy Research

Games have been widely used to explore possible courses of action in business, warfare, or diplomacy. Here, a more sophisticated format is used to investigate the conduct of U.S. foreign policy in an incipient crisis, and to study the style of decision-making itself.

The room was tense as everyone watched the President reach for the phone. To his right the Secretary of State busied himself with the draft of a press statement. Across the table the Secretary of Defense was drawing up orders to be transmitted to U.S. military commands in three continents, on "Yellow" alert since the upsurge of fighting in a Central American country.

The President signalled for silence. "We have a hot-line message to Moscow. Yes, that's right. And it must go right away. You already caught it on the closed-circuit TV? Okay, what do we assume for delivery time? Right. Thanks."

He leaned back, lit a cigar, and said in the voice of a man desperately short of sleep but determined not to show it, "That's all we can do. The U.S. is not intervening, and we can only hope the Russians don't misunderstand and start mixing in. If they do, we have no choice but to go in."

The Secretary of H.E.W., whose first National Security Council meeting this was, looked up. When he spoke, his voice was perhaps a shade too loud. "Dammit, Mr. President, we did the right thing. We probably avoided another Bay of Pigs and another Vietnam, and that's the way the American people and the Congress want it. So what if the Russians get involved? Why should we?"

The argument that had waxed and waned for two days and part of a hectic night seemed to be starting all over again. Three members of the National Security Council Executive Committee opened their mouths to join battle once more over whether America should respond militarily when the door opened and a secretary walked into the room, carrying a tray of sherry. "Control says it's time for lunch and would you please fill out your questionnaires before you come downstairs?"

The scene, it will now be clear, was not the White House Situation Room; rather, it was Endicott House, M.I.T.'s estate in Dedham, Massachusetts. The President of the United States was neither Lyndon Johnson nor Richard Nixon. He was, rather, a distinguished business executive with some Presidential pretensions and vast first-hand experience of government. His Secretary of State was not Dean Rusk or William Rogers or Henry Kissinger—but he *was* a high-ranking State Department official, just as "SECDEF"—the Secretary of Defense—was indeed a senior Pentagon official.

The role of Secretary of Health, Education, and Welfare presented a more complicated identity, since in real life he never *does* get asked to N.S.C. crisis meetings, on the fallacious premise that U.S. decisions about

Lincoln P. Bloomfield
Department of Political Science
M.I.T.

Cornelius J. Gearin
Center for International Studies
M.I.T.

involvement in local conflict situations have only political and military aspects. No real-life President normally invites spokesmen for Congress, the press, or young disaffected America, either, but *this* President did—or rather the M.I.T. Center for International Studies (C.I.S.) game designers did. We included representatives of these viewpoints for two reasons: we proposed to simulate an extended process of deliberations in which they might be expected to exert more influence than in a short, intense "crisis," and we suspected that most traditional models of U.S. decision-making had ignored their growing importance.

What, then, was all this about? It was CONEX I—first in a new series of political games, or simulations, or exercises—whichever you prefer—put on by the C.I.S., which for good reasons or bad had by the time of CONEX I (September, 1968) acquired an international reputation for "gaming out" with real-life government officials (and scholars and students) important issues of foreign policy.

Games as Analytic Tools

Briefly, a political game or exercise, which for brevity we will refer to generically as POLEX, is a dynamic interaction between two or more groups of players acting the roles of decision-makers. As we have used the technique at the C.I.S., the players are serious professionals from government and academic life. They have played, not to "win" (for one rarely "wins" in real-life international relations), but to see what can be learned in the way of alternative U.S. foreign policies, likely reactions to them, and the use of gaming to help in the process of policy planning and analysis.

As an analytic device, this kind of technique has varied origins. The "Kriegsspiel" (wargame) played in the 17th century by Prussian cadets and officers was a training substitute for large-scale and expensive maneuvers. German strategists adapted the Kriegsspiel prior to World War II to examine the political and military consequences of alternative courses of action. Ostensibly unrelated to this development, but contemporary to it, was the evolution of business or management simulations. Originally designed to train executives in information processing, decision-making techniques, and crisis reaction, simulation has also been adopted by psychologists and other students of decision theory as a research tool. Games in varying forms have been employed in classrooms from primary to university levels.

Specialists in international relations have attempted to computerize models of international systems to improve their understanding of the operative factors in these systems. Sophisticated computer-assisted models of strategic and tactical combat are used by several governments to assess relative force capabilities, weapons effectiveness, strategy, and logistic support. Though they are gross aggregations of reality, these models can simultaneously handle multiple variables and they partially compensate for being somewhat abstract with their high-speed capacity to repeat operations.

The POLEX, while profiting from these experiences, is unique, and consequently cannot rely for validity on other forms of simulation. The all-human (as contrasted with computerized) simulation of national security or foreign policy decision-making originated at the Rand Corporation in 1954, and since 1958 has been frequently employed at M.I.T. by the first-named author and others for teaching and analytic purposes. The general format employing two or more teams representing adversary governments plus a managing "Control Group" has been used in academic and government institutions here and abroad. Most of these games have simulated crisis situations that generally involve great powers on the verge of conflict. The product of these free and largely unstructured interactions has been an increase in understanding of complex issues by the participants.

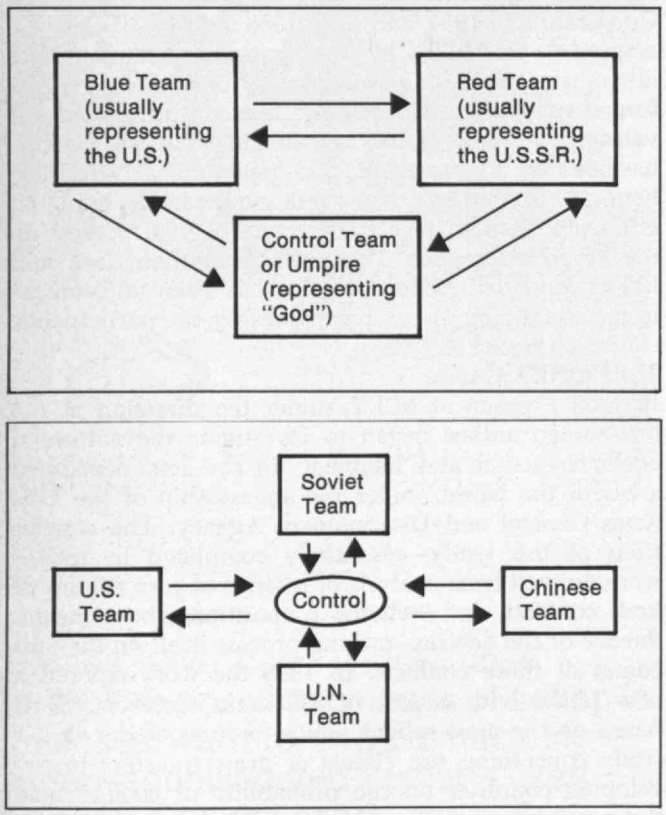
The CONEX Games

In 1963 a group at M.I.T. under the direction of the first-named author began to investigate the nature of conflicts, actual and incipient, in the less developed areas of the world, under the sponsorship of the U.S. Arms Control and Disarmament Agency. The conclusions of this study—essentially completed in 1967—were derived from analysis of a series of case studies of local conflicts, and included propositions about the influence of the decision-making process itself on the outcomes of those conflicts. In 1968 the work entered a new phase with a pair of follow-on research efforts based on the most salient policy findings of the earlier study concerning the effects of arms transfers to developing countries on the probability of conflict; and the possible correlation between decision-making style and U.S. foreign policy choices.

It was in support of this latter objective that the present authors collaborated in the design and direction of a new series of four political-military exercises under the acronym "CONEX." The arms transfer prob-

lem was the principal focus of CONEX II, but the other three exercises were devoted primarily to an examination of hypotheses about decision-making. They supplied a persuasive reason to turn to the professional-level "RAND-M.I.T." political exercise, using as the players real-life officials holding current responsibilities.

Thus we had a new interest in trying to make the political exercise a more responsive experimental tool. It had been generally conceded that the POLEX could be useful to social scientists, but was limited because its lack of rigor precluded either reliable prediction or explanation. It was not uncommon for a POLEX played by experienced government officials and academic specialists to generate interesting propositions about policy issues. But these results could not be classified as truly experimental for several reasons: they were unrelated to an accepted body of theory, the decision-making models employed in the games were not made explicit (they were usually confined in the heads of the players), there were no conscious efforts to establish correlations between variables, and there were no controls on idiosyncratic behavior. Consequently, the employment of the POLEX to examine specific policy and behavioral hypothesis required substantial modification of the structure and procedures of the traditional game.



The structure of an early political exercise (top) was much like that of a war game played by military and diplomatic strategists. A more sophisticated structure (bottom) was often used for later political games. This format controlled the game by mediating contact between teams through the interposition of a "Control" team.

The Nature of a Game

The structure of a typical war game (and early political exercises) in diagrammatic form, looked like the top illustration at the left.

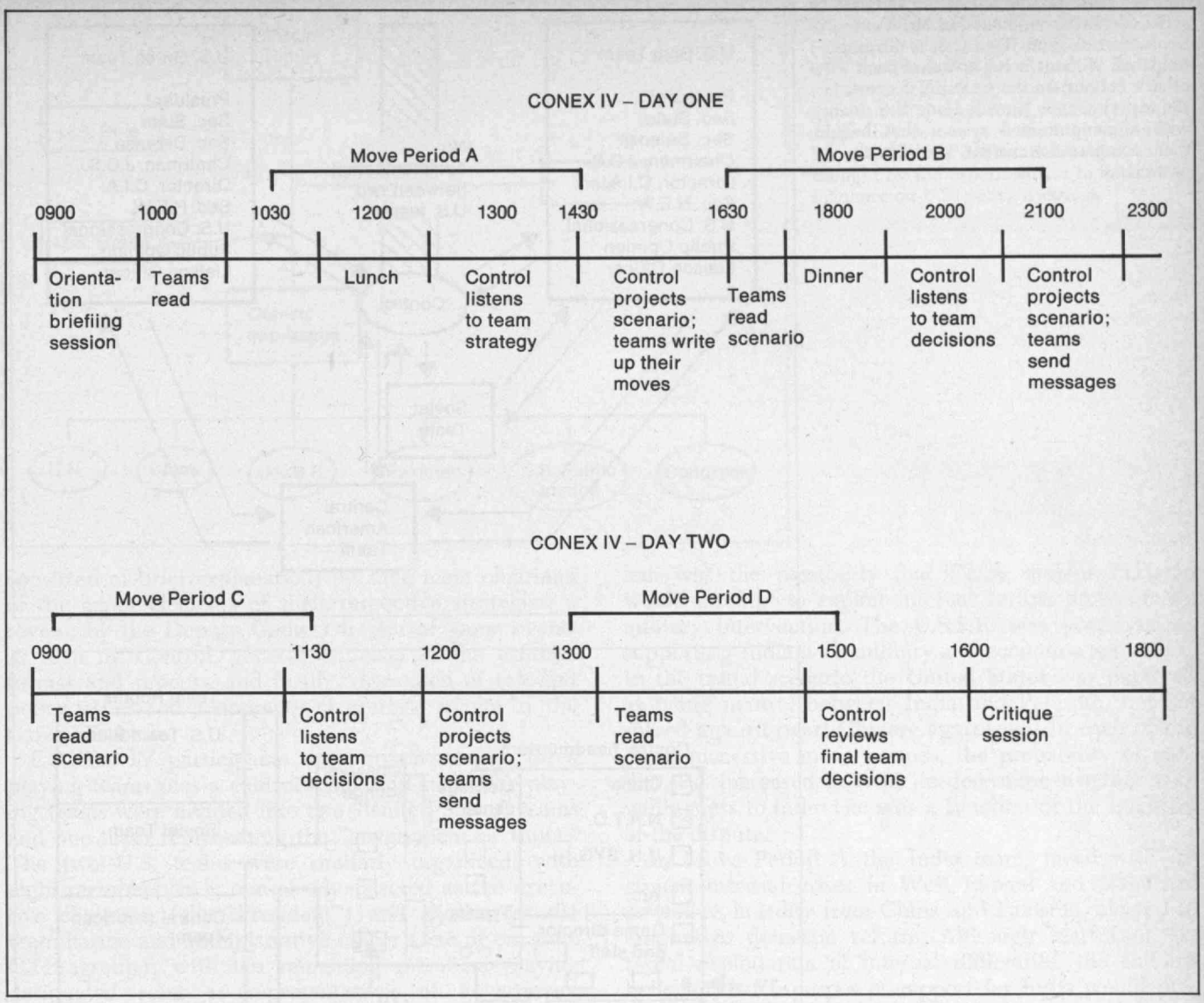
More sophisticated political games (say, of the M.I.T. variety) began to loosen up the model, while controlling the game more effectively through restrictions on inter-team contact, as shown at the left, bottom.

In the CONEX series, because we were interested in the way the U.S. government makes its decisions about involvement—or noninvolvement—in local conflicts, we wanted to simulate (in admittedly simplified form) the National Security Council level of U.S. government planning and action. But because we had some ideas of our own about self-imposed limitations on the present decision process, we added some additional "inputs" such as the Secretary of H.E.W. (who, as it turned out in one game, resigned from the U.S. team in indignant protest before the game was over!).

Being social scientists, and thus interested in scientific experimentation, we created not one but *two* similarly constituted teams of U.S. players, hidden away from each other and given identical information to respond to—but with a significant variable changed for one team only. We used closed-circuit TV and tape recorders so that our graduate students could monitor and tape every team conversation while filling out reams of forms for later analysis.

The CONEX model looked like the top illustration on page 54.

Actually, there were more "national" and "international" actors than this, because inside Control, in one- or two-man expert "subteams," were other inputs. Control itself was composed of a Game Director, Deputy Director, Liaison to the teams, a Communications Chief, and Military Advisers. But in addition were the "sub-teams" which, through a modified form of role-playing, represented China, N.A.T.O., the U.N., the



The time schedule for CONEX 4. At the beginning of the exercise, all teams were provided with a scenario in which China and Pakistan seemed to be preparing to exploit internal problems in India. Each team planned its actions and reported on them to Control, which, at the beginning of the second Move Period, issued a new scenario advancing the situation by three months. This process was continued through four Move Periods.

O.A.S., Cuba, etc.

The physical layout for such a relatively complex POLEX might resemble, in somewhat stylized form, the bottom illustration on page 54. When computerized message-handling was added for CONEX IV, each team and Control had a teletype console and operator.

Focus on a particular policy problem is created in the POLEX by means of a "Scenario-Problem." This is a document, up to a dozen pages in length, in which a hypothetical but plausible series of events—say, a revolution in a Central American country (which was the topic of CONEX I)—is depicted to the game players in some detail. This starts the game, and it remains the basis for the interaction between the teams and between the teams and the Control Group (and its sub-teams) for however long the game runs.

What Actually Happens?

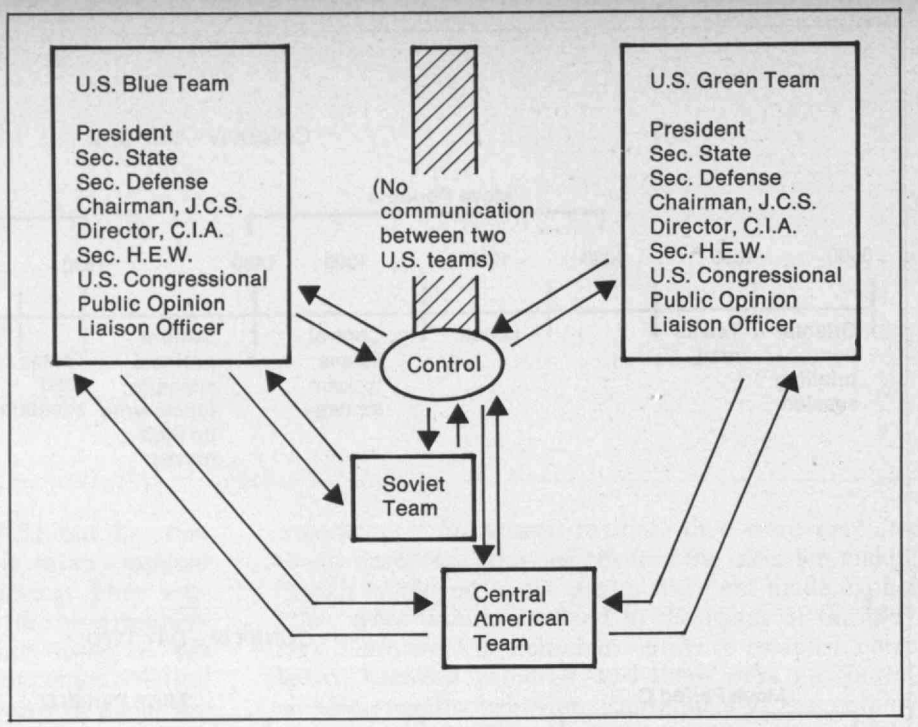
What kind of results could a game such as this generate? What form did they take? How could they be analyzed? What was their validity?

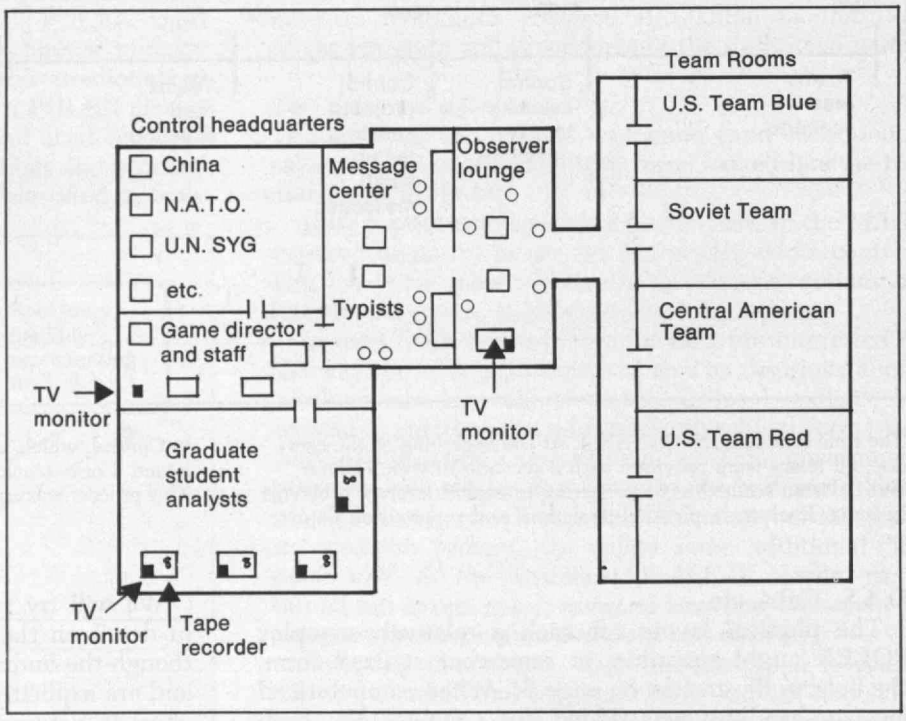
We will try to answer these questions by reporting in detail on the last game in the CONEX series. Although the findings of this research were very tentative and are explicitly qualified, they represent an academic effort to determine whether the way certain classes of crucial official decisions are made influences the ultimate policy choice. After describing the design, research innovations, problems, and results of the final experiment in the CONEX series, we will try to assess the utility of this method for further research in foreign policy.

CONEX IV was intended to examine several hypotheses about the extended process of decision-making in the United States government concerning pre-crisis conflict in the developing world. The main hypothesis that we examined in CONEX IV was that similarly constituted groups of decision-makers confronted by the same hypothetical situation will make different policy choices if one group is required to proceed in a more structured way than the other.

CONEX IV was conducted on September 18 and 19,

The structure and layout of the CONEX series of games, conducted at M.I.T. in September of 1968. Two U.S. teams participated, without being aware of each other's actions. In the CONEX 4 game, the experimenters provided one U.S. team with a computerized system that helped them compare the current "crisis" with past crises.

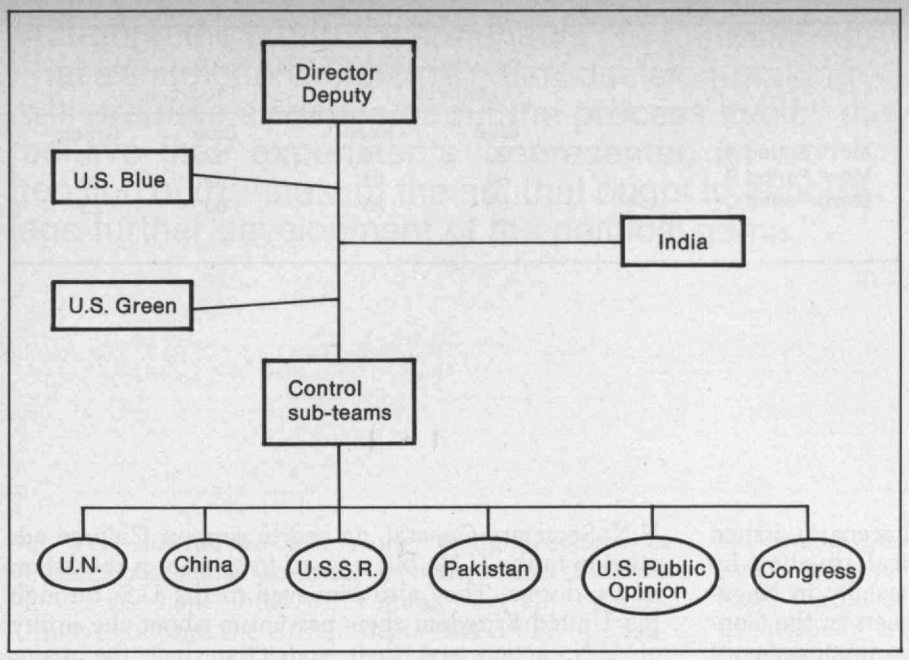




1969. The schedule of events (see the illustration on page 53) was constructed to maximize the opportunity for intra-team discussion and inter-team communication.

On the first morning all team members, control personnel, and administrative staff attended an orientation which described the purpose, scope, sequence of events, and rules of the exercise, and concluded with administrative announcements. Then team members adjourned to their respective rooms to read the scenarios and other exercise material issued upon their arrival. Simultaneously, control personnel were briefed on their responsibilities and operational procedures. Team discussions of the situation followed until lunch, after which each team decided upon a general strategy and major implementing programs. Before committing their strategy to writing, each team consecutively gave an oral summary of its strategy and programs. These summaries were observed on closed-circuit television by the control team, which then, without waiting for the written version, created an updated version of the scenario which reflected the results of the interaction between the teams' strategies. The updated paper went to the teams, which reacted once more. This process was repeated for each of four move periods. (Since we had *two* U.S. teams, it would have been necessary to design two different scenario updates if they had proceeded along different policy paths. One of the interesting features of the CONEX series was the extent to which the two U.S. teams generally followed a similar strategy of non-unilateral involvement.)

The exercise was concluded with a critique which



A schematic diagram of the participants in CONEX 4. Besides groups representing the interests of China, the Soviet Union, and Pakistan (all concerned in this exercise with the internal affairs of India), the Control team included representatives of groups within the United States which, while they do not participate in National Security Council deliberations, were thought by the experimenters to have an influence on U.S. policy decisions.

consisted of brief explanations by each team chairman of the major elements of their respective strategies, a review by the Deputy Game Director of game events as seen by Control, general criticism of the exercise format and process, and finally, discussion of relevant policy issues and a summary of exercise results by the Game Director.

CONEX IV participants were organized into three playing teams plus a control team, and staff. The playing teams were divided into two "United States" teams and one team representing the "government of India." The two U.S. teams were similarly organized, with eight members each, one of whom acted as the executive chairman (the "President") and another as the team liaison and administrative officer (one of our own C.I.S. group), with the remaining members playing designated roles as representatives of government agencies or the Congress. As indicated earlier, all team members were in real life senior government officials, members of Congress, or noted academic specialists. Individual role playing was confined to acting on behalf of an agency or interest in the most realistic way but without necessarily following established policy. Team expertise was balanced by assigning equally qualified specialists to both teams, and a cross section of attitudes for each team was assured by the administration of a pre-game questionnaire. These questionnaires were completed by everyone invited to attend, and assignments reflected their results.

The "Indian" team had five members who, except for the chairman, were not given separate internal roles but rather made collective judgments based on their expertise and wide experience. The Control team included "sub-teams" representing various interests, as shown in the diagram above. (It should be added that CONEX IV, unlike all the other 11 senior-level M.I.T./C.I.S. games, was held at the M.I.T. Center for Advanced Engineering Studies, in order to profit from their admirable technical and communications capabilities.)

Intervening in a "Crisis"

The CONEX scenario postulated a hypothetical incipient conflict in South Asia. The focus of the problem was the possibility that China and/or Pakistan would attempt to exploit internal Indian problems by military intervention. The U.S.S.R. was portrayed as supporting India with military and economic assistance. In the initial scenario the United States was depicted as being neutral between India and Pakistan, but resolved against overt Chinese aggression. In each of the three successive move periods, the probability of conflict was increased in order to determine whether U.S. willingness to intervene was a function of the intensity of the dispute.

In Move Period A the India team, faced with incipient internal crises in West Bengal and Nagaland as well as hostility from China and Pakistan, elected to emphasize domestic reform. Although fearful of external exploitation of internal difficulties, the Indians believed that superpower support for India would prevent overt aggression. The U.S. Blue team agreed with the Indian assessment that overt aggression was unlikely unless internal problems became exacerbated. U.S. Blue defined its major objective this way: "to minimize the chance of open hostilities between any of the great powers over the developing situation in South Asia." It believed political unity and economic progress in India to be essential to stability in the region. Its strategy involved diplomatic efforts to cool the international dispute, and economic assistance to India to help with its internal problems.

The U.S. Green team was more sanguine about the international situation than its Blue counterparts, primarily because it expected more Soviet cooperation. U.S. Green also shared the Blue team objectives, and generally agreed on strategy, although it was perhaps a bit more forcefully opposed to U.S. intervention. The major discernible difference between the two teams at the conclusion of the first move period was that U.S. Blue was much clearer about possible courses of action in the event its strategy failed. The U.S. Green team defined a number of contingencies, but admitted that its probable responses were not yet worked out. As said earlier, despite differences in emphasis both Blue and Green followed the same general policy track, and the other teams were aware of only one general "U.S. strategy."

A comparison of the number of times members of the two U.S. teams in CONEX 4 expressed objectives (leftmost two columns) and suggested programs (rightmost two columns). The U.S. Green team was given a computerized system to enable it to compare its "crisis" with past crises; that team proposed fewer objectives or programs than the Blue team, which had no computer.

	Specific Policy Objectives		Implementing Programs	
	Blue	Green	Blue	Green
Move Period A	20	14	17	16
Move Period B	80	31	69	36
Move Period C	53	25	60	23

Move Period B began with a revised scenario, issued to all teams, advancing the hypothetical situation by three months. Conditions in India, especially in Nagaland, were depicted by the Game designers in the Control Group as deteriorating rapidly. The announcement by China of an intention to test a ICBM in the Indian Ocean was widely viewed as nuclear sabre-rattling. India quickly cabled the U.S.

> URGENT. As you know the [Indian government] is most gravely concerned over the announced Chinese ICBM test which may be a nuclear test as well. This action threatens India's very existence. We urgently seek your assurance that you will not tolerate or permit the threat of nuclear blackmail against India.

Shortly thereafter the U.S. teams received a long message from the Soviet Union promising cooperation in aid to India, assuring no Soviet intervention unless other great powers interfered, and asking U.S. views on the desirability of "counteraction with respect to the forthcoming Chinese ICBM shot."

Faced with a growing crisis in South Asia, the U.S. Blue team renewed efforts to involve the United Nations, warned Pakistan in strong terms not to exploit Indian problems, solicited other governments to influence Pakistan, and informed the Soviet Union that:

> We do not have information which would . . . justify overt military action by any nation against China. . . . our first objective is the preservation of world peace.

The U.S. Blue team also informed India of its warning to Pakistan, minimized the security aspects of the Chinese ICBM test, and promised to honor its commitment under a U.N. Security Council resolution to cooperate in the defense of a nation attacked by nuclear weapons.

The U.S. Green team also took a strong line with Pakistan, threatening to cut off all aid unless Pakistan desisted from interference with India. U.S. Green also sought to engage the U.N. in an effort to reduce tensions in the area, but emphasized U.S.-Soviet bilateral cooperation. The U.S. Green team then sought to engage all area arms suppliers in a slowdown of weapons transfers to the area. In a message to India, Green concurred with the Blue assessment (but without knowing it) that the Chinese "ICBM test" was propaganda.

The Indian team, responding to a suggestion from the U.N. Secretary General, agreed to support Chinese admission to the U.N., but refused to sponsor a resolution under duress. They also conveyed to the U.S. through the United Kingdom their pessimism about the utility of U.N. action and their conviction that the major threat to India was from China, not Pakistan.

At the conclusion of Move Period B, it was apparent that both U.S. teams disagreed with the Indian assessment, and by a combination of pressure on Pakistan and aid to India still hoped to cool the crisis. The main difference between their positions was that Green gave more importance to regional arms control than Blue. They both believed that U.S. military intervention was incredible, and moreover India's internal problems were not susceptible to resolution by Washington, at least in the short term.

Move Period C advanced the situation three days; the changes it reflected were few but serious. The teams were told of an attempted assassination of the Indian Prime Minister, an increase in communal violence, an upsurge in skirmishing in Kashmir, and an obvious Soviet effort to use the Sino-Indian difficulties as an excuse to intervene against China. The Indian team in a cool note to the U.N. Secretary General rejected his suggestion to send his personal representative and U.N. observers, concluding:

> . . . the Government of India is willing to allow the visit of U.N. observers . . . provided that the Governments of Pakistan and China agree to such visits on exactly the same terms.

The U.S. Green team sought to reopen talks with China in Warsaw, asked the United Kingdom to convene an international conference "of major parties," and sent the following message to the U.S. ambassador to India:

> Please contact Commander in Chief and Home Minister. Tell them that we are concerned with keeping Pakistan cool as well as constrained, and that an Indian reduced profile in patrol action for the next few weeks would help. (For your information: Our goal is to reduce border conflict and Pakistan's real, imagined, and public-relations related insecurities).

The U.S. Blue team also made overtures to the Chinese, threatened to cut off military supplies to Pakistan if border violence was not curtailed, asked the Soviet Union to do the same, and in a very different tone from U.S. Green cabled New Delhi:

Although the authors were unable "to demonstrate that a simulation of foreign policy decision-making will produce evidence about the process itself," they believe their experiments "represented an extension of the 'state of the art' that ought to encourage further development of the political game."

> Tell Indians we have made strong demarche in Islamabad about irregular incursions into Kashmir . . . We hope India will refrain from any military moves beyond the current demarcation line in Kashmir.

Near the end of the move period the Indian team received an ominous cable from Moscow saying in part:

> You will have seen the press reports of the dastardly and unprovoked Maoist attack against our border to which we are administering a decisive and drastic rebuff . . . We are continuing to consider other drastic measures re the Chinese ICBM shot.

The Indian reply to this message (which also proposed Soviet-Indian military staff discussions) sought to maintain a policy balance in her relations with the superpowers. The Indians then arranged for rumor to be circulated to the effect that they would shortly acquire nuclear weapons.

Faced with these developments, the U.S. Green team settled for urging Moscow to limit the Sino-Soviet border clashes. The U.S. Blue team also advocated Soviet restraint, but decided that:

> . . . If India ever has evidence of nuclear aggression against India, or the threat thereof, we would consider deployment of U.S. forces to a position supporting India should this prove necessary.

With this, the exercise was concluded.

A Difference in Decision-Making Style

As shown by the flow diagram on page 58, the U.S. decisions (as in all our games in the late 1960s on potential U.S. intervention) all fell in the area of minimizing hostilities and, with the exception of Blue toward the end, of U.S. non-involvement.

One "independent" variable in CONEX IV was the style of decision-making adopted by the U.S. teams. The U.S. Blue team was unconstrained in its process of decision. The U.S. Green team, while confronted by exactly the same situations as Blue, was required to consult a computer-aided system for storing, retrieving, and analyzing data on local conflicts. This system, CASCON, was itself an experiment conducted by our Arms Control Project contemporaneously with the CONEX series. CASCON stores data on past local conflicts including expert judgments regarding those factors which contributed to the intensification of individual conflicts, and enables the analyst to input a new case in order to make on-line comparisons with the data base. We believed that the requirement for one team to rationally consider previous and analogous experience while the other team relied on memory (or ignored history) constituted a significant difference in decision-making style. We therefore hypothesized that the U.S. Green and Blue teams would choose different solutions to the same problem.

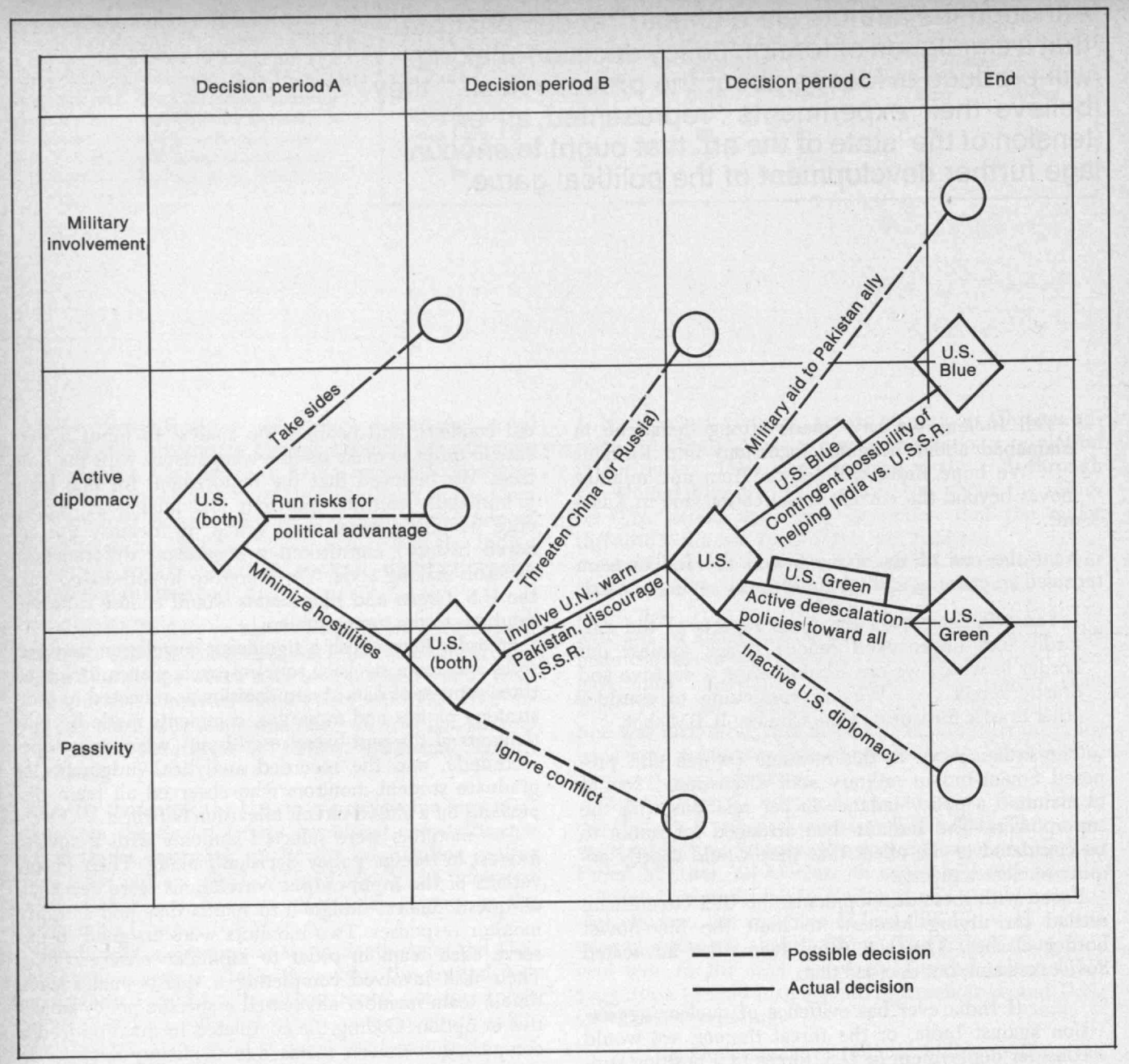
In order to establish a significant correlation between style and team decision, our research plan anticipated three sources of data: team decision as reflected in their strategy papers and messages, comments made by participants at the post-exercise critique (which was tape-recorded), and the recorded analytical judgments of graduate student monitors who observed all team discussions on a closed-circuit television network.

The monitors were selected students with a special interest in foreign policy decision-making. Their observations of the input-output correlations were recorded on questionnaires designed to standardize and simplify monitor responses. Two monitors were assigned to observe each team in order to minimize observer bias. Their task involved completing a questionnaire each time a team member advocated a specific policy objective or option. Coding the completed forms produced a comparison between teams and evidence of shifts in team attitudes from one period to the next.

Although the results were not statistically significant, they did reflect interesting differences. In the first move period policy objectives (such as "strengthen the Indian government" or "keep India democratic") were advocated on twenty occasions by the Blue (unconstrained) team. Policy objectives were proposed at about the same rate (14) on the Green (CASCON) team during the first period. However, in subsequent move periods members of the Blue team mentioned twice as many objectives as their counterparts on the Green team. This trend was repeated for recommendations pertaining to implementing programs, such as "the use of economic aid as a policy lever" or "diplomatic activity in the United Nations" (see the table on page 56).

The Overpowering "Vietnam Syndrome"

In order to determine whether differences in behavior might be the product of varying perceptions of the situation, monitors were required to complete another series of questionnaires. These questionnaires asked the monitor to assess how the team under observation per-



A display of the decisions made by the two U.S. teams in CONEX 4. Though their decision-making processes differed, their decisions usually did not. In general, both teams sought to avoid unilateral involvement. Though CONEX 4 involved a growing crisis in India, this result may be due to a distaste for such involvement produced by the nation's experience in Indochina.

ceived the extent to which either Moscow or Peking was responsible for the Indian dilemmas, and how they perceived prospects for Soviet or Chinese gains from the situation. The results of these questionnaires suggested that the teams correctly interpreted what the scenario attempted to convey; that the monitors usually agreed on team perceptions; and that the only significant difference in team perceptions was over the extent to which China could profit during Move Period C.

Analysis of these questionnaires convinced us that observable differences in team policy choices would not be attributable to subjective observation by the monitors or to misperception of the situation by team members. We were also satisfied that the "decision-making styles" of the U.S. teams were in fact different. Nevertheless, there was no significant difference in their policy choices. Both teams eschewed U.S. military intervention. In the absence of that option, while preferring multilateral solutions, both advocated U.S.-Soviet collaboration to reduce the probability of hostilities.

It would appear that the difference in the decision-making process was simply overpowered by the "Vietnam syndrome." The almost unanimous distaste for U.S. military intervention in local conflict (also reflected in the other CONEX games) prevailed despite clear prospects for gains by competitor states and an admitted lack of confidence in other policy alternatives.

In addition to changing the purpose and structure of the political exercise, CONEX IV also experimented with a revised communications system. Its predecessors

relied on a manual system which required all messages to be typed, reproduced in many copies and distributed by messenger. Handling 100 or more messages reproduced in fifty copies in an eighteen hour exercise was onerous and also delayed delivery times. Since "game time" is sharply compressed from reality (hours of the former often representing days or weeks of the latter), we became concerned that this physical limitation might artificially limit team interaction. M.I.T. student G. Allen Moulton designed a computer program whereby secretaries assigned to each team and Control could type a high-priority message on a console connected to the M.I.T. Compatible Time Sharing System and almost instantaneously transmit the message over a telephone data link to any desired combination of recipients. The program was designed to preclude inadvertent transmission of messages between U.S. teams, and to provide for storing the message until the addressee's console was free, and then transmitting. The system functioned well and has excellent potential for expediting game communications.

Televising team sessions to Control, monitors, and observers was an unqualified success. It minimized distractions to team members and Control personnel, permitted Control to anticipate questions and team moves, and helped the monitors to interpret what they were hearing. There is no evidence that the small camera and microphones positioned unobtrusively in the team rooms had any effect on deliberations. Tape recording team discussions and the critique also proved valuable as a memory aid and as corroboration for other data sources. These tape recordings were especially helpful in the analysis of contradictions between monitor reports and apparent inconsistencies between team discussions and their decisions.

Although many of our procedural innovations in the traditional POLEX proved successful, we were unable to demonstrate that a simulation of foreign policy decision-making will produce evidence about the process itself. The central hypothesis was unproven because an intervening variable—the Vietnam syndrome—apparently exerted an overpowering influence. CONEX IV may not have been a conclusive test of the hypotheses in which we were interested. But it did provide a unique connection between experimental method and the highly intuitive judgments of foreign policy practioners. In our judgment the CONEX series represented an extension of the "state of the art" that ought to encourage further development of the political game.

Suggested readings

Serious Games, Clark C. Abt, Viking, 1970.

Simulation Games in Learning, L. S. Babcock and E. O. Schill, eds., SAGE Publications, 1968.

Arms Control and Local Conflict, Vol. II, *Anticipating Conflict-Control Policies: The CONEX Games as a Planning Tool,* L. P. Bloomfield and C. J. Gearin with J. L. Foster, M.I.T., Center for International Studies, C/70-10, February, 1970.

"Games Foreign Policy Experts Play: The Political Exercise Comes of Age," L. P. Bloomfield and C. J. Gearin; *Orbis,* Winter 1973.

"Computers and Policy-Making: The CASCON Experiment," L. P. Bloomfield and R. R. Beattie, *Journal of Conflict Resolution,* March, 1971.

The Control of Local Conflict: A Design Study on Arms Control and Limited War, L. P. Bloomfield, A. C. Leiss, and L. J. Legere, G.P.O., 1967.

Controlling Small Wars: A Strategy for the 1970s, L. P. Bloomfield and A. C. Leiss, Knopf, 1969.

Business Simulation in Industrial and University Education, P. S. Greenlaw et al., Prentice Hall, 1972.

Some Effects of Decision Procedures on Policy Outcomes, J. D. Steinbruner, M.I.T., Center for International Studies, C/70-9, February, 1970.

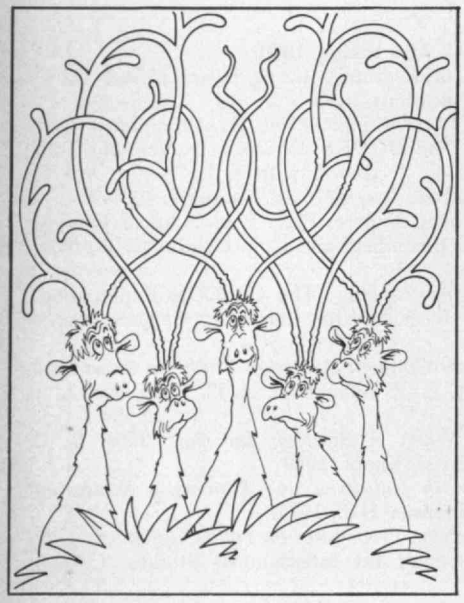
Authors' Note

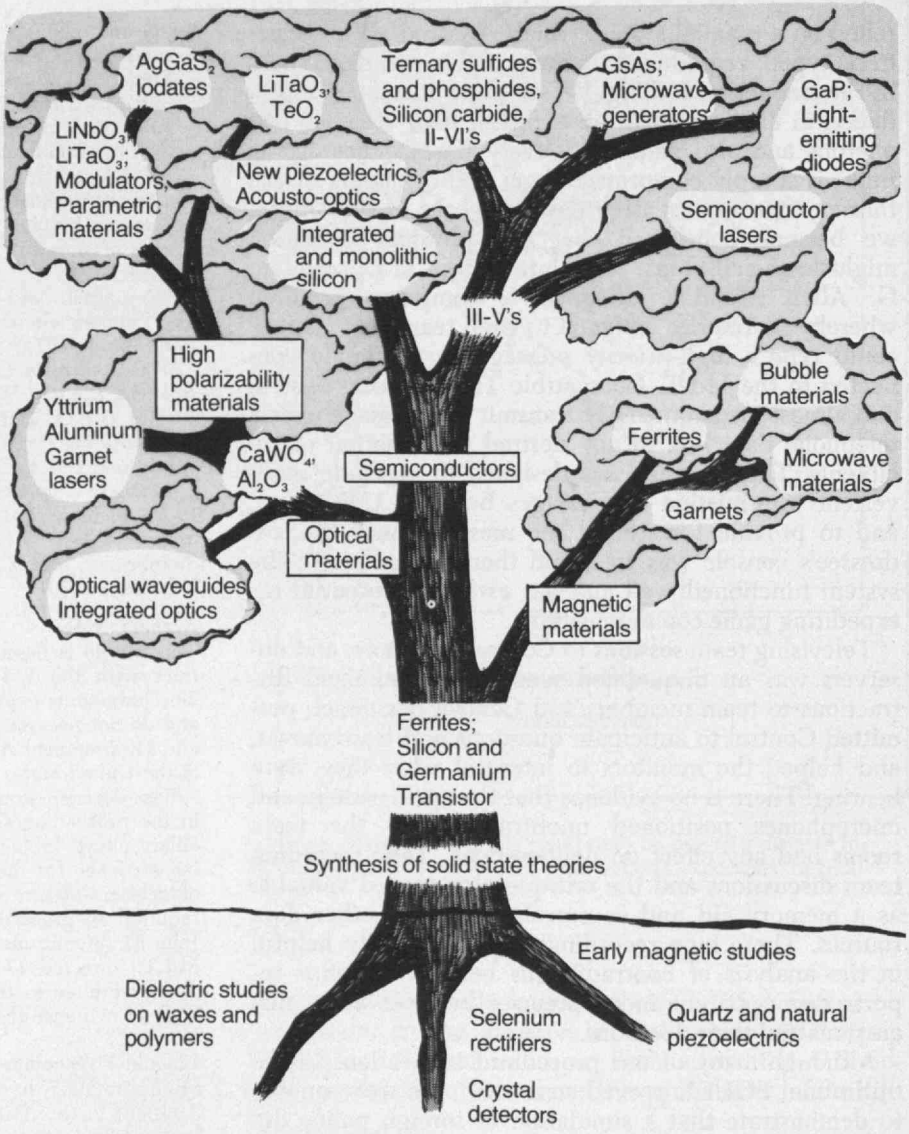
This article is based in part on research performed under contract with the U.S. Arms Control and Disarmament Agency. The judgments expressed in the article are those of the authors and do not necessarily reflect the view of the U.S. Arms Control and Disarmament Agency or of any other department or agency of the United States government.

The decision to conduct CONEX 4 was based on experience in the preceeding CONEX games and on the results of an ancillary effort dubbed EXCON. In an effort to generate supporting evidence for the hypothesis that similarly constituted groups of decision-makers will make different decisions if one group is required to proceed in a more structured way than the other, John D. Steinbruner, Assistant Professor of Political Science at M.I.T., directed 17 "mini-games" with teams composed of students recruited in the Boston area. EXCON produced a relevant body of evidence that encouraged us to proceed.

Lincoln P. Bloomfield joined the M.I.T. Center for International Studies in 1957, having for the previous five years been a Special Assistant to the Assistant Secretary of State. His work at M.I.T. has involved studies of the United Nations, arms control, the control of local conflict, political aspects of outer space, and European security; and he is the principal originator of the political-military gaming techniques which are described in this article. Professor Bloomfield's collaborator, **Cornelius J. Gearin,** is a Ph.D. candidate in the M.I.T. Department of Political Science and has twice held brief appointments as Research Associate in the Center for International Studies; he is an officer of the U.S. Army with the rank of Colonel.

Thirty years ago, a decision-maker might have invested heavily in the further development of vacuum-tube technology. Three years later, the transistor was invented. Where is the future of electronic materials now?





The Electronic Materials Tree, and another tree whose branchings are somewhat more confused. Each might symbolize progress in the interdisciplinary field of electronic materials. The roots of the first tree lie in the basic sciences and in early studies of materials such as those used in Thomas Edison's inventions. The trunk signifies the development of the transistor—the solid-state device that superseded the vacuum tube. The branches represent three areas of current electronic materials progress: *semiconducting materials* more complex than those used in early transistors; *magnetic materials*, now being used in computer memories; and *optical materials*, for use in light-emitting, transmitting, and modulating devices. The second, and more uncertain, scheme was drawn by Dr. Seuss for *If I Ran the Zoo*, copyright 1950 by Dr. Seuss. Reprinted by permission of Random House, Inc.

Robert A. Laudise
Kurt Nassau
Bell Telephone Laboratories

Electronic Materials of the Future: Predicting the Unpredictable

In the late nineteenth and early twentieth centuries, prophecy was a cottage industry indulged in by Jules Verne and H. G. Wells. By now, it is a fully mechanized growth industry in the hands of the Rand Corporation and the Hudson Institute. Yet Alvin Toffler puts it nicely when he quotes the Chinese proverb: "To prophesy is extremely difficult—especially with respect to the future." In spite of this difficulty, materials science must have its Cassandras, and electronic materials—perhaps the bellwether discipline of materials science—deserves special examination.

The Past and the Present

On economic terms alone, the electronics industry commands attention. Since its start with the invention of the transistor in the late 1940s, it has grown to an annual sales level exceeding $25 billion. Projections for 1975 suggest nearly $33 billion annual sales.

Materials are the life-blood of the electronics industry. The first practical transistor, for example, relied upon the unique properties of germanium. That element belongs to Group IV of the periodic table—that is, germanium atoms each have four electrons in the outermost electron shell. Germanium is ordinarily a poor conductor at room temperature, but if we add a trace of an impurity such as arsenic, whose atoms contain five electrons in the outermost shell, the "extra" electron from each arsenic atom can move from atom to atom in the germanium crystal lattice. In this way, the conductivity of the material can be made appreciable, depending on the amount of arsenic "doping," and arsenic is said to be a "donor" of electrons. On the other hand, if we add an element such as boron, whose atoms contain only three electrons in the outermost shell, the electron-"deficient" boron atom can be thought of as a positive hole in the germanium lattice. In an electric field, an electron from a germanium atom can move to a nearby boron atom, making boron an "acceptor" of one electron, and moving the hole to the germanium atom.

Conductivity in arsenic-doped germanium is described as conductivity by electrons, and such material is called n (negative) material; conductivity in boron-doped germanium is described as being due to the motion of holes, and such material is called p (positive) material. An abrupt change in doping from, for example, arsenic to boron, results in a p-n junction, or diode—it allows the passage of current in only one direction, and thus converts alternating current to direct current. If a material is suitably doped—for example, p-n-p—and suitable leads are then attached, it can act as an amplifier. This is the simplest transistor.

For these effects to be appreciable, we require a material in which conductivity will be controlled by the concentration of added impurities. Germanium is appropriate because it is a semiconductor in the pure, intrinsic state. The atoms in the crystal lattice are bound together by shared electrons, but such a bond can break by the transfer of one electron, simultaneously producing a free electron on one germanium atom and creating a hole on an adjacent atom. Yet the electronic structure of germanium is such that at moderate temperatures, there is not enough energy for this self-initiation of the conduction process to occur. Speaking in terms of quantities of energy, the "ground state" and the "conduction band" are separated—the "band gap" is fairly large.

In addition to these atomic properties required for a good semiconductor, it is also required that the material be a highly pure, single crystal. Purity is necessary so that foreign impurities do not contribute to or impede the conduction process. Single crystals are required because the boundaries in multi-crystal samples often contain undesirable impurities and because the boundaries scatter the conducting electrons and holes, reducing their mobility.

Thus, the invention of the transistor required the invention of a technique for preparing materials with less than a few parts per billion harmful impurities and the utilization of special techniques to prepare highly perfect crystals. Similarly, almost every electronic milestone since the first transistor has entailed a materials discovery and called for the refinement of the quality and perfection of a material. Moreover, there has been continuing growth in the complexity of the materials with which the materials scientist deals. In the early semiconductor days, germanium was superseded by silicon, which greatly extended transistor capabilities and caused a virtual electronics revolution. But obtaining equivalent quality crystals of silicon required the solution of a number of difficult materials problems. Purification techniques often involve moving a molten zone through a solid ingot, and growth techniques often require pulling a crystal from a "melt." Now, silicon's melting point is 1412°C. while germanium's is 937°C. Using a parameter as crude as melting point, we see, for example, that today's demand for good quality yttrium aluminum garnet (melting point: about 1980°C.) has thrust us into a new universe of difficulties.

Indeed, the materials scientist has assumed responsibility for three distinct areas interfacing with solid-state electronics and technology. In each, he is the central figure and driving engine of progress; and we believe that each controls the rate at which crucial segments of solid-state theory and practical technology develop. Let us examine these areas.

1. *The discovery and innovation of new materials with useful electronic properties.* New physical phenomena are sometimes discovered in materials taken off the shelf, but optimizing a property to a point where it is useful, either for conducting research or for making useful devices, almost always requires new or at least vastly improved materials.

The illustration on page 60 shows one way of viewing the genesis of new materials, "the electronic materials tree." The roots of the tree lie in the 20s, 30s and 40s. They include the Edisonian uses of solid materials in radio and telephone apparatus, and the early studies aimed at optimizing the properties of these materials; and they include the roots of solid-state materials theory, which lie deep in the sciences of physics, chemistry, and metallurgy.

The transistor was, however, the great watershed for both theory and practice. It would be well to bear in mind when we begin our attempts to divine the future that the invention of the transistor was not a random event. To be sure, it involved a flash of genius, but it arose in a context of conscious desire to investigate a new area of science—the solid state. That area was felt to be "ripe" for theoretical discovery, and it was realized that such discoveries might produce economically useful results for telecommunications.

The success of the first investigations gave decision-makers confidence that further investment in the solid state would pay handsomely, both scientifically and in dollars. Comparatively soon, germanium gave way to silicon. New device capabilities were opened up by semiconducting compounds such as gallium arsenide (called III-V compounds because they are formed from elements of the third and fifth groups of the periodic table), whose materials problems required new levels of process sophistication and physical and chemical measurements.

The growth tips of the semiconductor branches of our tree now involve materials such as gallium phosphide, which is used in light-emitting diodes. In such devices, holes and electrons in a fairly large band-gap semiconductor are caused to combine, emitting light with high efficiency. Gallium phosphide is particularly attractive because its band gap is such that it emits in the green where the human eye is especially sensitive.

Gallium aluminum arsenide is used in semiconductor lasers. Here, the light emitted by hole and electron combination is produced and confined by careful control of the semiconductor's conductivity and the material's optical properties so that its amplitude is in phase—the light is coherent. As many as six different layers of controlled doping on a scale of microns are required.

The processing sophistication required for these compounds is extreme. The control of impurities to less than the parts-per-billion level is now commonplace; the preparation of devices such as semiconductor lasers requires more than a trivial understanding of materials science, coupled with the patience of a Job.

On the magnetic branch of our materials tree, innovations in the 50s and 60s have led to controlled properties in insulating magnetic materials, so that devices such as magnetic memories could be obtained without the need for single crystals. The polycrystalline ferrites are an example. Other innovations include the discovery of new magnetic substances like the garnets, and the use of single-crystal magnetic materials in microwave devices. The growing tip of magnetics activity presently involves exploration of miniaturized information storage in magnetic domains within single crystals.

At the present time, the optical branch of the electronic materials tree is flourishing, and here new materials innovation has played a key role. Optical devices have required the development of new single-crystal materials such as yttrium aluminum garnet doped with neodymium ions, which is used in lasers. It has a high melting point—which is important because much energy is dissipated in a laser, and one wouldn't want one's laser to melt—and it is doped with an ion—here, neodymium—which lases at low energy. In the host material, an ion of similar radius and charge is required to provide locations for the impurity. In this case, it is aluminum.

Several optical devices are used in combination with lasers. In modulators, the frequency or amplitude of laser light is affected by an electric field, so as to impress information on a laser beam. To do this, we use materials with a large electro-optic effect—materials in which an applied electric field produces a large change in the index of refraction, and thus a change in the velocity of light passing through. In a harmonic generator, laser light of one frequency is, for example, converted to light whose frequency is double that of the original frequency, while remaining spatially and temporally coherent. In a parametric oscillator, laser light of one frequency is converted to a variety of coherent frequencies. Thus harmonic generators and parametric oscillators let us produce laser light of new frequencies.

As a by-product, the search for materials in which an electric field would strongly affect the optical properties has stimulated discovery of new materials in which mechanical strain produces large electronic or optical effects. Thus, materials such as lithium tantalate, which produces an electric charge in response to pressure, and tellurium dioxide, which modulates light in response to sound waves, are all results of recent materials innovation.

The potential of optical communication has generated materials activities directed toward the preparation of extremely low-loss optical waveguide fibers and thin, light-guiding films. In fact, a whole new technology of "integrated optics" seems on the horizon. Many optical functions might be performed on a single chip of material, in a manner analogous to integrated circuits, in which many electronic functions are performed on a single chip.

We shall return later to how we expect the growth tips of the electronic materials tree to develop, or, more importantly, how we endeavor to graft, force-feed, and sometimes prune the various branches of the tree. Lest we be accused of over-simplification, it would perhaps have been more honest to use an illustration from the children's story, *If I Ran the Zoo,* by Dr. Seuss, to illustrate the connections between materials innovations.

We do not believe that we can improve upon Dr. Seuss' explanation:

A father, a mother, two sisters, a brother
Whose horns are connected, from one to the other,
Whose horns are so mixed they can't tell them apart,
Can't tell where they end and can't tell where they start!
Each deer's mighty puzzled. He's never yet found
If his *horns are* hers, *or the other way'round.*

The perfect definition of a flourishing interdisciplinary field.

2. *Understanding the connection between chemical bonding, structural, and electronic properties.* A corollary to finding new materials, of course, is improving our ability to predict materials properties. Thus, understanding the relationship between chemical bonding, molecular and atomic structure, and electronic properties has played an important role in the growth of our tree. We dare say a good part of the tree was grown by good Edisonian perspiration, but as our materials systems become more complicated and more recalcitrant to prepare, we must improve our predictive power or the cost-benefit ratio of finding new materials may well preclude future research. One need only use M.I.T. Professor Arthur Von Hippel's term *molecular engineering* to elicit all the proper connotations about this activity. We believe that fostering this part of materials science is one of our primary responsibilities for the future, and we will return to this subject.

3. *The improvement of processing techniques.* Besides the discovery of new techniques, this area includes the improvement of our descriptions of materials (the "characterization" problem) and the extension of our understanding of the interrelation between processing and properties. We must look at the interplay of processing, characterization, and theory if we are to assess the future.

Progress in processing techniques has always been essential to progress in electronic materials. We have already cited the preparation of semiconductors with less than parts-per-billion impurity levels. Another example is the economical growth of quartz crystals for frequency standards, electronic oscillators, and filters. This processing technique required an understanding of theory—in this case, the physical chemistry of high-temperature aqueous growth solutions at pressures greater than 25,000 pounds per square inch. Characterization problems were also involved: impurity determination at parts-per-billion levels, the mapping of individual dislocations in a crystal lattice, and the understanding of the relationship between impurities and changes in the properties of materials. These are all examples of characterization progress stimulated by solid-state needs, and used by solid-state scientists to make critical device progress.

Successful materials work invariably involves detailed characterization. An outline of the characterization problem is given in the table on page 64, which is only a partial listing of all the possible characteristics of a crystal. Similar summaries could be made for glasses, ceramics, and so on. Ideally, one should have detailed data for each item in such a summary. The techniques for obtaining data for some of the characteristics of the table are well known. Yet for others there are no generally useful approaches.

Consider, as one example, the determination of stoichiometry—the ratios of chemical elements in a substance. In water, for instance, one expects from the formula H_2O to find a two-to-one ratio of hydrogen to oxygen in any volume of that compound. But compounds are known in which deviations from stoichiometry can occur to the extent of ten per cent or more—for example, in intermetallic compounds and some metal oxides. However, compounds such as CdS and $LiNbO_3$ are usually expected to have only fractional percentage variations in their compositional ratios—smaller than can be determined by chemical analysis. At such times, indirect techniques must be tailored for each specific material. In the case of CdS, studies of the electrical properties can give an indication of the stoichiometry.

$LiNbO_3$ is used in harmonic generators. For such devices to double the frequency of laser light while retaining the light's coherence, it is essential that the index of refraction be extremely uniform throughout the material. Now the index depends on the ratio of the compounds Li_2O and Nb_2O_5 in the melt from which crystals of $LiNbO_3$ are grown. It has recently been found by G. E. Peterson and co-workers at Bell Laboratories that a surprisingly wide compositional range—from about 45 to a little over 50 per cent LiO_2—occurs for $LiNbO_3$; in fact, the mixture for which the solid crystal and the melt have the same composition is not the exact one-half Li_2O, one-half Nb_2O_5 dictated by stoichiometry—that is, by the formula Li_2O plus Nb_2O_5 yields $2LiNbO_3$. Instead, the so-called "congruent melting composition" is 48.6 per cent Li_2O.

The importance of this type of compositional variation, and the fact that congruency does not occur at the stoichiometric point, is extremely significant for electronic devices. If a crystal is grown from the stoichiometric melt (half Li_2O, half Nb_2O_5) with five-degree temperature fluctuations lasting 0.5 seconds, this will produce variations in the composition of the crystal, producing in turn refractive index striations very serious in a material for use in an optical harmonic generator. Magnetic resonance techniques of characterization coupled with special crystal growth procedures have resulted in the preparation of crystals with homogeneity suitable for optical devices.

Some of the characterization techniques of the table on page 64 (such as X-ray and neutron diffraction used for structure and perfection assessment, and electron microscopy and low-energy electron diffraction for surface studies) have reached high levels of sophistication or are well on the way to it. Other techniques (such as magnetic resonance) are used for electronic materials characterization only incidentally. It is, in principle, possible to use any physical measurement for characterization, but meaningful control of properties occurs only when measurements are closely coupled to preparation procedures in such a way as to optimize the device behavior of the material.

Predicting 1974 from 1944

Before we talk about the future, it would be well to calibrate our performance as seers by going back 30 years to 1944 and trying to guess what a prognosticator then would have advised the decision-makers of 1944 to do to bring about his version of what was desirable for

Elemental composition

1. Precise ratios of major elements (i.e., exact stoichiometry)
2. Concentration of all foreign elements
3. Characterization of outermost electron shell of crystal constituents and impurities
4. Distribution of inhomogeneities and impurities

Defect characteristics of the crystal lattice

1. Characterization and concentration of vacancies, interstitials, and substitutional defects
2. Dislocation concentration, nature, and distribution
3. Grain boundary structure

Structural characteristics

1. Structure type
2. Precise lattice parameters
3. Location of atoms within the unit crystal cell

Surface characteristics

1. Chemical nature of the crystal surface: Are impurities concentrated or diluted?
2. Structural nature: surface defects; Which atoms are exposed?
3. Depth and nature of the natural surface layer
4. Depth and nature of the surface damage caused by cutting, polishing, etc.
5. Gas and moisture absorption on the surface: How fast do surface layers respond to environment?

A partial listing of the characteristics of a crystal—the facts that together comprise a description of that class of materials. Innovators may need detailed knowledge for each item on such a list, but sometimes there is not even a generally usable technique to investigate a given characteristic. Similar lists exist for other types of materials—glasses, ceramics, and so on.

the year 1974.

In the first place, there was no such thing as materials science in 1944, so our seer would have had to be a chemist, physicist, metallurgist, or some such *Ausländer*. The second and most important fact in the milieu of 1944 is that the transistor was not to be invented for three more years. Therefore almost all simple linear extrapolations of conventional nonelectronic technology would have been wrong. A linear extrapolator might have decided in 1944 to put his money on improving the vacuum tube.

Linear predictions extrapolate existing trends, foresee the fuller utilization of current technology, and visualize solutions to present needs. This type of forecast is well within the province of competent technologists, part of whose training consists of finding solutions to given problems and pursuing technologies to their logical consequences. A limitation of the majority of linear predictions is, of course, the relatively short time scale to which they apply.

A second type of forecast is the nonlinear prediction. Here one deals with discontinuities in technology. Conventional scientists and technologists by their very training are usually reluctant to assay nonlinear predictions. However, there is a group of people who specialize in nonlinear predictions: the writers of science fiction. Unfortunately, on examining the aggregate of science fiction's predictions, it becomes clear that their percentage of successful forecasts has been near zero. Given time, the science fiction writers will include in their writing a description of essentially all the technologies of the future, yet there is no way of picking these out from the many alternative but irrelevant-to-the-future technologies that are equally convincingly portrayed.

The most important thing for our seer to know in 1944 was that some wise people had decided that the solid state was an important area to investigate for telecommunications technology. With this fact, he could go beyond linear extrapolations. Clearly, some 1944 decision-makers chose the right, the relevant, area to support.

The Future: Predicting It

With all this as prologue, let us now look to the future. What will happen in electronic materials science? Better yet, what do we want to happen, and how can we make it happen?

First, what are some possibilities?—goals with a large

A single crystal being grown by the Czochralski crystal pulling technique by A. A. Ballman and L. G. Van Uitert at the Bell Laboratories. A melt typically contained in an iridium crucible is held near the melting point by radio frequency heating and a seed crystal is inserted and slowly withdrawn while being rotated. Crystallization takes place on the seed while the crystal is slowly being "pulled from the melt." The lower photo shows a simulation model of the stirring patterns near the melt-crystal interface in Czochralski crystal pulling. Studies of the hydro-dynamics associated with crystal growth are pointing the way toward improved crystal quality. (Photo courtesy J. R. Carruthers)

materials-science content, which we might steer toward. Perhaps we will be excused for listing some of our private dreams first:

—Low-cost, low-voltage, high-efficiency *light sources;* light-emitting diodes throughout the visible range of the spectrum. It may be that we could light whole rooms in this way. Shorter term goals include better light-emitting diodes and controlled p-n junctions in large-band-gap materials.

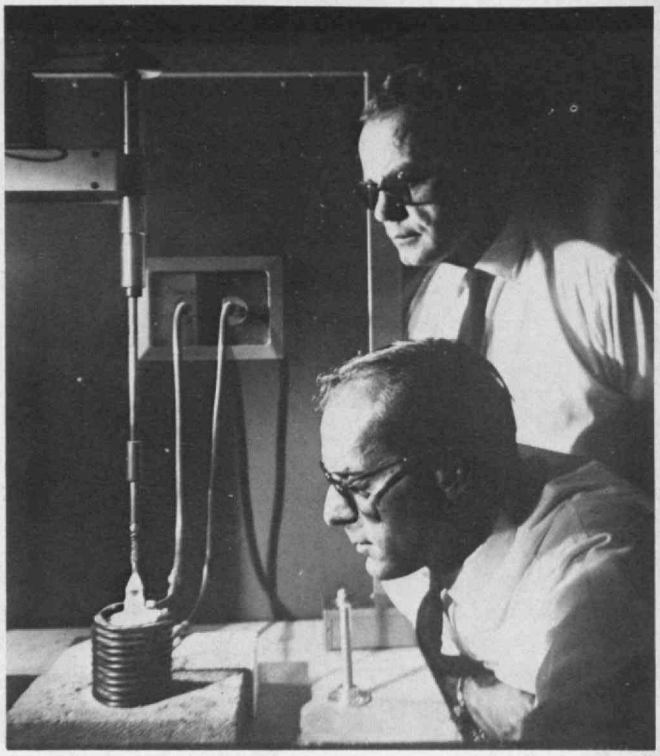
—*Optical communication* for information, voice, pictures, on immense band capacity cheap channels. In optical communication, we hope to use laser light as the information carrier. Light is electromagnetic radiation of much higher frequency than radio or microwaves. Therefore a given channel is capable of carrying much more information: since it itself is at a high frequency, we can modulate an optical carrier at a very high frequency. For this, of course, we need efficient lasers, modulators, detectors, and a glass fiber transmission medium—all materials problems. Short-term goals include low-loss fiber optics, optical thin film circuits, and better laser and modulator materials.

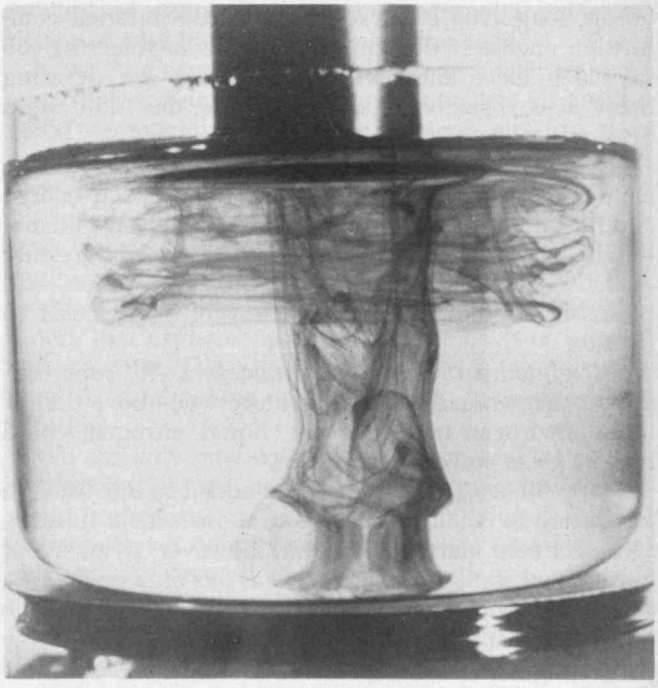
—*Graphics and phone-to-phone video communications,* which the Bell System has already named "Picturephone."© If you can't make it to grandma's for Christmas, then one wall of your dining room becomes a screen, and the families dine together, hopefully at the price of a 1974 long-distance call. To fulfill this goal, highly sophisticated communication must become a reality. For the shorter term, improvements in the quality of silicon imaging devices are needed.

—*Improved computers.* The electronic slide-rule is now a reality, based on extremely complicated integrated and hybrid circuit technologies. But we could use yet another advance in this area. Improved capacity, speed, reliability, and cost reduction could make artificial intelligence, the large-scale prediction of weather, etc. practical. From the materials viewpoint, we need super-large-scale integrated circuits, and perhaps magnetic bubble memories—single-crystal materials that will sustain small bubble-like magnetic regions, which can move at high velocity.

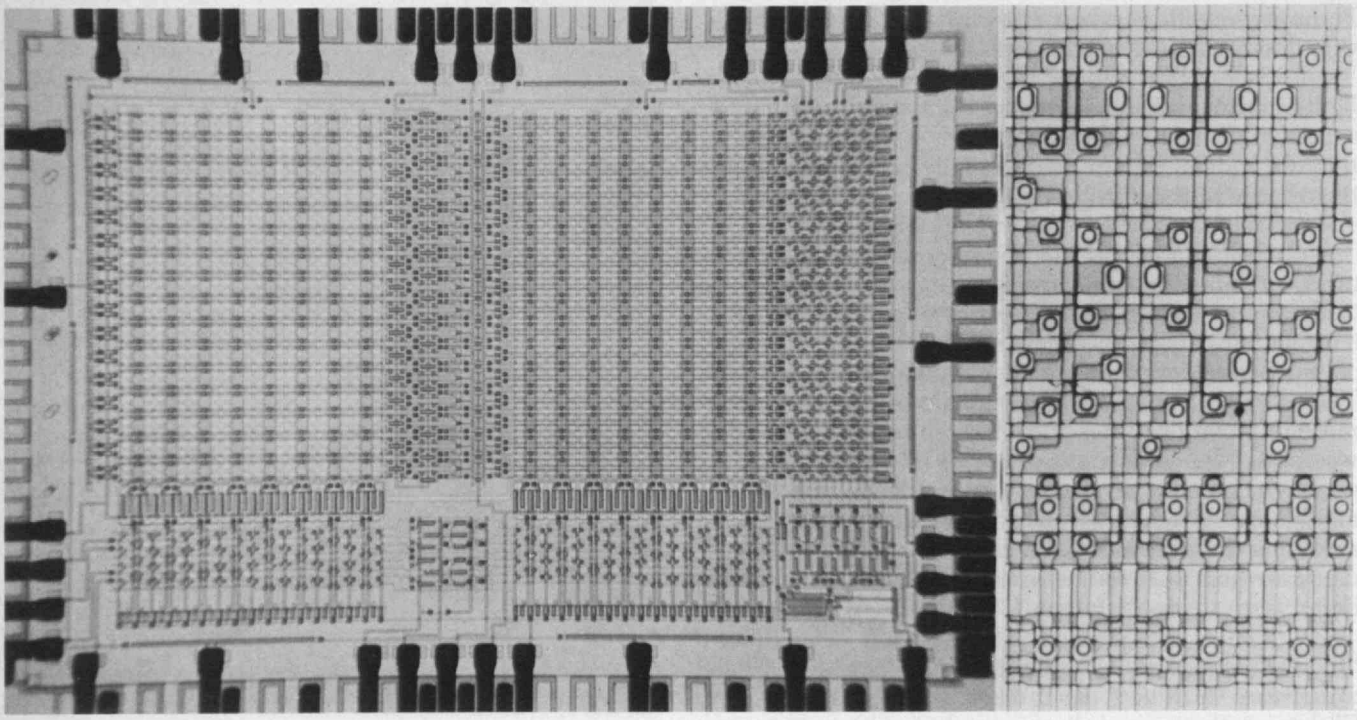
—*Prosthetic devices* for the handicapped. From the electronic materials viewpoint, this too is a matter of reliable, very-large-scale integration. In addition, electronic materials techniques and approaches should prove useful in the search for improved implant materials.

—*Low-pollution transportation.* Finding an efficient,





An integrated circuit 1024 word random access memory chip, 0.11 × 0.155 inches in size, containing 1875 transistors and 1025 capacitors (left); detail 0.012 × 0.024 inches (right). (Photo courtesy of H. J. Boll and W. T. Lynch)



cheap, long-lived catalyst for use in the internal combustion engine is the sort of materials engineering job to which electronic materials scientists are devoting themselves. Their viewpoint, expertise, and skill could be of critical assistance in this problem.

—*Low-pollution energy sources.* Magnetohydrodynamic generation, fuel cells, new batteries, solar energy and fusion generation all have important electronic materials implications. New or improved materials, either as active system elements or for instrumentation, will probably be required to bring any of these fields to fruition.

—*High-temperature superconductors.* A superconductor that worked at a temperature well above that of liquid hydrogen or, better yet, liquid nitrogen, could revolutionize power transmission.

Many other examples could be added to our list. We have tried to confine ourselves to those with a substantial electronic materials content. However, if we adopt our list and similar applied goals as our only guidelines, we will be dooming materials science to a narrow role and a constrained usefulness. We have neglected the overriding objective for materials science of the future: furthering our basic understanding of materials, how to prepare them, and what influences their properties and perfection.

Directions for the Future

How, then, do we proceed to manage the future? Can we arrange matters in some basic areas of science so that these areas will generate new phenomena which stimulate new materials and new applications—as solid-state physics did in the 40s?

First, we should mention our belief that solid-state physics itself may become a more applied science, and research and development in telecommunications and related technologies may move more and more toward materials. Thus it is not only necessary to materials science but also to those areas of society dependent upon solid-state technology that we find the right path. We must operate in close concert both with physicists and with device designers and systems engineers. Moreover, we should expect the discovery of new phenomena and increasing general sophistication in chemistry. The worst thing we could do is to form an electronic materials institute divorced from physics, chemistry, and

engineering inputs. We believe these inputs should come from close interdisciplinary contact.

Let us now outline some important directions for the future:

1. *Innovating new materials.* First we must encourage modest logical extensions of present materials work. These include such things as long-life diode lasers, optical materials whose properties are not damaged by intense laser light, larger band gap semiconductors, etc. In our view, this activity is the crux of the next ten years' progress. Every major organization has its own value judgments here, and we will add ours only on what we consider to be a few neglected opportunities:
—*Ternary semiconductors*—semiconducting compounds containing three chemical elements, thereby giving more freedom in designing devices but producing additional problems of control. $CuInS_2$ can be made both p- and n-type; its band gap is 1.5 electron volts. $CuAlS_2$ has a band gap of 3.3 electron volts. They belong to a most interesting family of chalcopyrites. They are, we believe, only the tip of an iceberg of chemical, solid-state physical, and perhaps technological goodies.
—*Small-domain magnetic materials.* Their device potential is fairly well known. However, the recent successes in growing layers of magnetic garnets on nonmagnetic substrates by liquid-phase epitaxy should do much to direct our attention to L.P.E. growth of inorganic materials. (In this technique, a substrate material is placed in a solution, which deposits a new layer upon it, in such a way that the crystal lattice is continuous across the boundary.) Integrated optics, for example, cries out for thin films of controlled composition inorganic materials.
—*Low optical loss solids.* Laser communication systems require glass optical waveguide fibers with losses of less than 10 decibels per kilometer—preferably below one decibel per kilometer. We believe that the application of physical tools of characterization will be important to the solution of this problem. Our experience with laser damage in $LiNbO_3$ may provide an illustration. Until recently, intense laser light always induced severe index of refraction inhomogeneities in many optically useful materials. In $LiNbO_3$, electron paramagnetic resonance readily identified iron (which had escaped detection by conventional means) as the culprit associated with damage, and rapidly guided materials scientists to an order of magnitude reduction in the damageability of the material.

2. *Extending our process and synthesis capabilities.* Here are some examples of future possibilities:

"Large-scale integration" is the term applied to producing many device functions in a single crystal of material. It requires high yields of devices produced in a sequence of processes, each having many steps. Computer control of crystal growth, already a reality in quartz and silicon production, should be extended to help achieve this. Subtle diagnostic tools will be needed for process control and trouble shooting.

Is silicon technology coming to a po nt of diminishing returns? Can we find a technology with equal flexibility and room for future sophistication which does not require a hundred serial process steps—as does silicon production? Could magnetic bubbles be the answer?

The physics and the physical chemistry of crystallization must be better understood. In particular, fluid flow as applied to crystal growth shows large and comparatively short-range promise of yielding useful results. The use of statistical mechanics and computer simulation to predict the rate of growth, shape, and perfection of real crystals—this shows longer-range promise of eventually giving us understanding at the atomic level. We have already seen great strides in the practical use of surface physics and molecular beam techniques in fabricating devices by molecular beam epitaxy—the use of a beam of molecules to deposit a layer on a substance.

We should extend our pressure and temperature capabilities. Large-scale gallium phosphide crystal growth in high-pressure liquid-encapsulated systems is a recent example of the results of such advances. Growth systems capable of using oxygen as a growth environment at high pressures would be a boon to many studies. Additional techniques for stabilizing non-equilibrium forms such as those produced by very rapid "splat" cooling open new areas. Operation at temperatures above 2000°C. is rare, and only a few materials have been prepared above 3000°C. Techniques such as melting with lasers, plasmas, and electron beams could be extended.

3. *Opening up new classes of materials:*

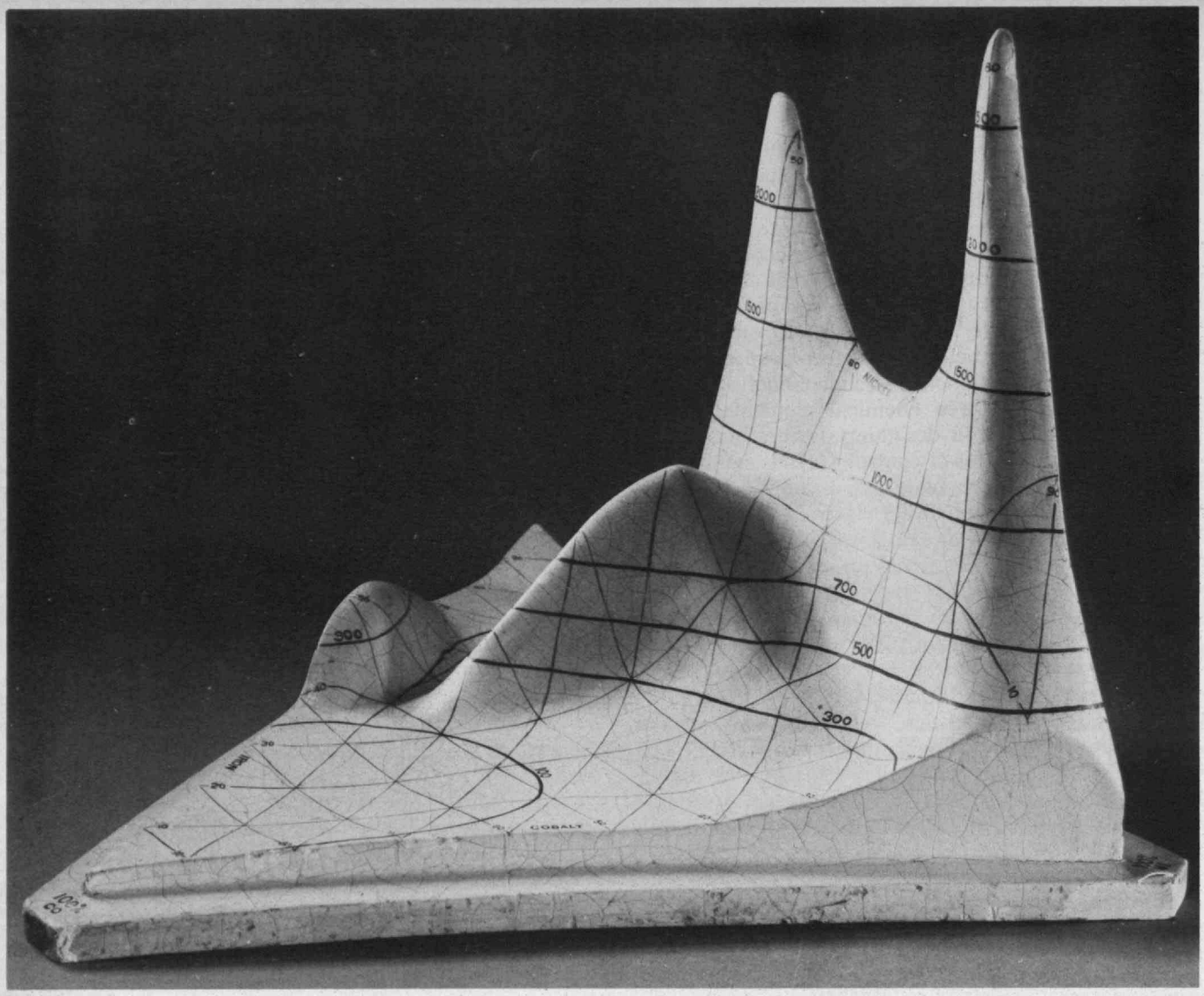
Metal-organics and compounds with other shielding chemical groups, where one controls the atomic interactions so as to make magnetic materials, conductors, and hopefully superconductors, are examples of classes of materials where the chemist and the materials scientist can profitably collaborate.

Most solid-state devices are in essence two-dimensional: transistors, resistors, and capacitors in integrated devices are fabricated on a semiconductor surface. The depths involved are so small that thin-film and epitaxial technologies are applicable. The same can be said of most magnetic devices and semiconductor lasers. We should, perhaps, bend our efforts toward the use of truly bulk properties to extend the two-dimensional devices to a full three dimensions. One can imagine a solid cube of material containing a three-dimensional network of components without external interconnections and with high reliability and efficiency.

More "conventional" new classes of materials, such as carbides, selenides, high oxidation state transition metal compounds, inorganic polymers, rare gas compounds, organic electronic materials, glasses, etc. should receive discerning scouting activities.

Chemistry could pass to what might be seen as a new stage. Its present emphasis is on preparing all possible combinations of the chemical elements, studying their reactions and products, and consolidating a chemical theory that explains properties on the basis of bonding and structure. The aim, in other words, is to understand reaction mechanisms and properties in terms of constitution.

We are only now coming to the full realization that single crystals are essential for the measurement of many properties, and also for many possible solid-state devices. But a conservative estimate is that less than one out of every thousand chemical compounds has been prepared in crystals one millimeter in size or larger, so work in this area has clearly just begun. The difficulty is that while it may take one or a few days to



There are many useful properties about which we possess little theoretical knowledge, and thus little ability to make predictions that could facilitate innovation. The graph shows the magnetic permeability of the iron-cobalt-nickel system—in other words, a measurement of the permanent magnetism possible in varying mixtures of those three metals. Without theoretical knowledge, the existence of high peaks in this property could not be anticipated. The left and right corners in the foreground correspond to pure cobalt and pure nickel respectively; the back corner corresponds to pure iron.

synthesize a given compound in powder form, weeks or months may be required to devise an adequate crystallization technique for the same compound. In addition, there are many variables involved in perfection, stoichiometry, and impurities (intentional doping and unintentional contamination). In the case of silicon, for example, fruitful investigation is still in progress after some 25 years of intensive study.

The expensive and time-consuming work involved in crystal growth can generally be justified only when some specific device of wide applicability seems feasible. Yet broad programs of investigation are necessary in fundamental areas so that the background information will be ready for the next generation of materials. An example of the complexity involved in locating the optimum of a property in the absence of fundamental understanding is shown in the illustration above, a graph of the magnetic permeability of the ternary iron-cobalt-nickel system. The location of maxima, and indeed the possibility of the occurrence of such large values of a property, are presently completely outside our capability of prediction for this system, as is the case for most other properties of interest in electronic materials.

4. *Improving our ability to predict electronic properties and design on an atomic basis.* Here the active fields are presently in metal physics and inorganic chemistry. Our goals should be to move the center of gravity of some of these activities toward the fundamental study of electronic properties of current usefulness in materials of reasonable stability.

The More Distant Future

In the previous sections, some areas of importance to the immediate future have been noted. Now we will attempt to take a long-term point of view—toward the twenty-first century.

It has been written of cancer research: "Certainly, much money and trained manpower are required to conquer cancer. But these are not the most important ingredients . . . it will be necessary . . . for an individual

scientist, unprejudiced by previously learned doctrines, to notice and correctly interpret a hitherto unknown property of malignant tissue." (H. Elias, *Science* 175, 1312, March 24, 1972). Such significant advances are nonlinear, as opposed to the linear nature of predictable developments. They cannot be foretold, but it is perhaps possible to suggest areas in which such developments may occur. They will likely be areas that are currently out of fashion or as yet untouched. Here are some areas which seem to us to be ripe:

Semiconductor behavior has been observed in organic materials. Yet the whole human body, including the brain, uses a very different electrical system, one involving electrolytes (solutions of ions) and semipermeable membranes. This system is much more compact, although perhaps not as rapid, as electronic circuitry. The duplication of even a single nerve cell with its connections seems presently to be completely out of the question. Here, surely, is an area of great potential for future systems.

"Liquid crystals" are ordered like solids in some directions but disordered like liquids in others. They are currently under investigation, and it seems that a significant fraction of organic compounds and mixtures can form such structures. Since there are several million organic compounds, the variety of organic liquid crystals to be investigated becomes overwhelming. New phenomena may lurk hidden in such a forest, and after many collisions with the trees some predictability surely can be expected.

The surfaces of solids are currently under active investigation. A more detailed understanding might lead to specific control of the chemically unsatisfied bonds in a surface and to structured super-thin films only a few atoms thick. The possibility of new electronic devices as well as the catalytic potentialities are apparent.

Electronic materials will surely have their role to play in the energy crisis. Electricity storage devices, fuel cells, and catalysts are areas where crucial needs could stimulate significant innovation. Materials with large pyroelectric coefficients, electrets, high-temperature conductivity, and molten salt materials with electronic and ionic conductivity in the range above 500° are all understudied and we believe of future significance.

The Future: Managing It

How do you generate the discovery of new phenomena or new theories? Support and train good people, give them freedom, and be ready to exploit opportunities. We *must* do this. Quality researchers at the leading edge of materials science will always be our *sine qua non.*

Another important requirement is a close and continuous interaction between the materials scientist and the potential user—perhaps a physicist measuring electronic properties or a builder of devices. Much time and energy can be saved, and much additional insight gained, when a variety of investigative techniques are brought to bear on the same problem, and even more is gained if research is correlated with the variables involved in the materials preparation process.

Now we come to the question of who should perform the materials science of the future and, perhaps even more important, who should pay for it. Our answer is obvious: It should be done by private industry, universities, and the government, and it should be paid for by private industry and the government. It is our belief that private industry underspends on materials science, especially considering how many of its problems and opportunities involve materials limitations. Materials scientists must proselytize for their discipline.

The university's primary role should continue to be the training of materials scientists. As chemists, we would like to see more chemical discipline involvement in that training. Many of our problems and opportunities are uniquely chemical, and a chemical-materials scientist is a rare and useful bird. Give us more! Fundamental research, both for its tutorial value and as a source of new basic knowledge, is, of course, the other function of the university, one in which materials science should grow. We might consider giving a bonus in research funds for every thesis truly supervised jointly by a materials science professor and a chemistry or physics professor.

The government should play an integrative role. Data collection and assessment, standards and techniques research *a la* National Bureau of Standards, government in-house defense and fundamental materials research on a scale to provide competence for contracting officers—all these should be government activities.

We believe that it would be premature and presumptuous of us to seriously address the organizational or funding aspects of electronic materials research. Instead, we want to close by conveying, if we can, the intense pleasures, the satisfaction experienced by those of us lucky enough to work in this field. Socially useful, intellectually challenging, in need of good research and development, in need of imaginative and dynamic people—this describes, and we believe will continue to describe, electronic materials science. If we can convey this to a new generation of scientists and, better yet, of informed laymen who pay for and in the end direct this enterprise, we will have done our job.

Robert A. Laudise is Assistant Director of the Materials Research Laboratory at Bell Telephone Laboratories, which he joined in 1956 after receiving his Ph.D. in inorganic chemistry from M.I.T. His interests include materials preparation and crystal growth. He is an editor of the *Journal of Crystal Growth,* the author of more than 70 publications and a book, *The Growth of Single Crystals,* and the holder of 10 patents.

Kurt Nassau received his Ph.D. in physical chemistry from the University of Pittsburgh. He joined Bell Telephone Laboratories in 1959, and has been working there in the field of crystal chemistry. He is currently a Supervisor in the Crystal Chemistry Research Department of the Materials Research Laboratory. He is the author of about 120 publications, including two book chapters, and holds 13 patents.

Hewlett-Packard presents a small miracle, the HP-65:

the only fully programmable pocket-sized computer calculator, $795.

Once you had to know a "computer" language, work at a desk and have a large budget to use programming. No longer.

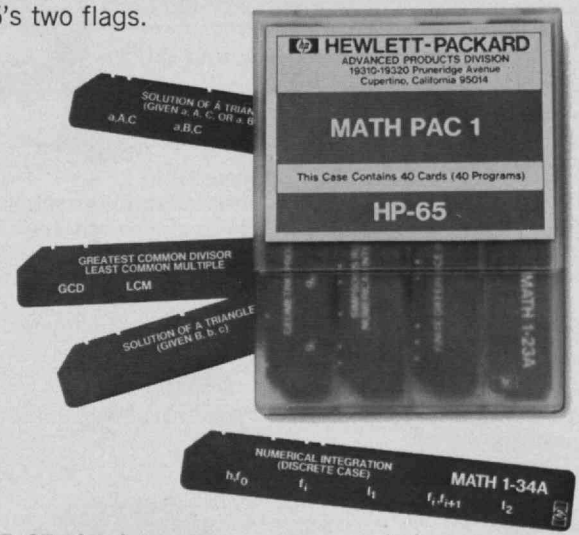
The HP-65 is fully programmable.

It's the first fully programmable pocket-size computer calculator in the world.

With an HP-65 you can write programs just by pressing the keys in sequence, without using a special "computer" language. You can edit programs, i.e. add or delete steps at will. And you can record your programs on magnetic cards for subsequent use anywhere.

The HP-65's 100-step program memory, in combination with its 51 pre-programmed arithmetic, logarithmic, trigonometric and exponential functions, its operational stack and its nine addressable memory registers, permits you to write exceedingly complex programs.

Its user definable keys let you program up to five routines using any of the machine's pre-programmed capabilities. You can also label portions of your program so the calculator can branch to a specific instruction or choose between alternate computational paths based on logical comparisons ($x=y$, $x\neq y$, $x>y$, $x\leq y$) or the condition of the HP-65's two flags.



The HP-65 also lets you use pre-recorded programs.

HP offers a series of pre-recorded program packages called Application Pacs at $45* each. Each Pac contains as many as 40 programs dedicated to a specific discipline. Our newest are Aviation, Marine Navigation and Finance. Also available are pacs for Electrical Engineering, Mathematics, Statistics and Medicine.

We also maintain a Users' Library of owner-contributed HP-65 programs which are itemized in catalogs distributed periodically to subscribing owners. Programs may be ordered from the Library for a small handling fee.

The HP-65 is a powerful pocket-sized calculator.

The HP-65 ranks with our popular and powerful HP-45 as a keyboard-operated calculator. It's pre-programmed to handle 51 functions and operations.

The HP-65 is priced at just $795.*

What you gain in time, precision and flexibility may well save you that amount in a matter of weeks. The price includes one 11-ounce HP-65 with rechargeable battery pack, AC adaptor-recharger, carrying cases, a year's subscription to the Users' Library, Owner's Handbook, Quick Reference Guide and a Standard Application Pac that contains 17 representative pre-recorded programs, 2 diagnostic cards, 20 blank cards, a head-cleaning card and instruction booklet.

You can have your HP-65 in 2 weeks.

We've now caught up with an unexpectedly large initial demand for the HP-65. So, if you send us the coupon and your check for $795, we'll send you an HP-65 for a 15-day money back trial within two weeks. Or, you can call Customer Service at (408) 996-0100 for the outlet nearest you. Chances are, the HP-65 will be in stock.

HEWLETT hp PACKARD

614/29

Sales and service from 172 offices in 65 countries.
Dept. 237G, 19310 Pruneridge Ave., Cupertino, CA 95014

Hewlett-Packard
Dept. 237G
19310 Pruneridge Ave., Cupertino, CA 95014

Please send me:

- ☐ HP-65(s) including Standard Application Pac at $795 (domestic U.S.A.) each plus applicable state and local taxes. (Check enclosed.)
- ☐ Detailed specifications on your HP-65 and available Application Pacs.
- ☐ Detailed specifications on your full line of pocket-sized and pre-programmed desktop calculators.

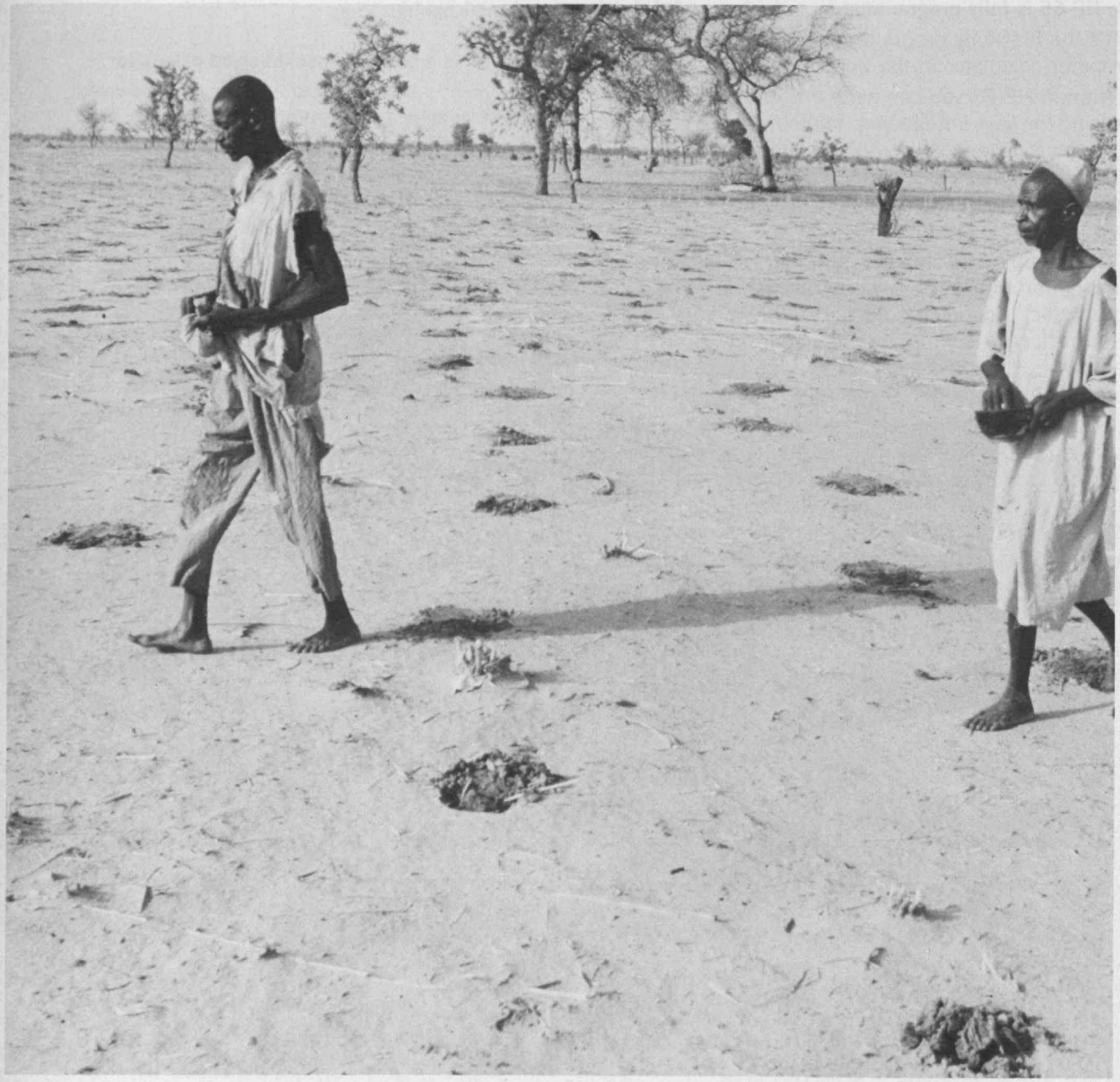
Name_____

Address_____

City_____

State/Zip_____

*All prices domestic U.S.A., not including applicable state and local taxes.



The procedure for planting millet in Chad is simple: dig a small hole, drop in the seeds, cover, and hope for rain. The amount of rainfall in the summer and early fall determines whether there will be a harvest. Chad, part of the Sahel region of Africa, has experienced drought conditions since 1969. (Photo: Agency for International Development)

Trend of Affairs

Trends This Month

ENVIRONMENT

"Tragedy of the Commons" in Africa

Can an area two-thirds the size of the U.S., inhabited by only 24 million people, have an overpopulation problem? If the area is the Sahel-Sudan, the arid region south of the Sahara in West Africa where drought is causing widespread famine, the answer is yes, considering its current level of technical and economic development.

"It's a classic example of the tragedy of the commons," according to William Seifert, Director of the Sahel-Sudan Project at M.I.T.

The project was begun last year when it became apparent that the Sahel needed a self-sustaining plan for long-term development as much as it needed immediate disaster relief. The AID-sponsored multidisciplinary effort has attempted to take "the detached broad view to identify the critical issues."

One of the most obvious critical issues is the weather and, says Dr. Seifert, "Overcoming the effects of a cyclical weather pattern is something that hasn't been solved in the U.S. either." According to Dr. Seifert, the current drought is not particularly worse than the previous 18 or 19 the region has suffered in the last 400 years. It is instead the unusually high levels of rainfall between 1950 and 1968, combined with the introduction of Western medicine and technology, that caused the population to outgrow the maximum normally imposed by the severe environment. "The area suffers from overuse," Dr. Seifert said.

About the reports that the desert is moving south at the rate of 30 miles per year—true, thinks Dr. Seifert, though not in the sense of a sand dune moving relentlessly onward. The desertification has been caused not by the drought but by the chain of events the drought has set in motion. For example:

In the Sahel live the nomads, who follow the rains to the north every year and retreat to the south in the dry season. Their numbers have traditionally been limited partially by the number of cows and goats the land was able to support, and by the distance between water holes. Western agencies working in the area during the past decade made the obvious but ill-advised move of digging wells throughout the grazing commons. The numbers of cattle, and people, grew proportionately, using much of the grazing land for the greater part of the year instead of seasonally, allowing the land no time to recover. The herds moving southward during the dry season have been forced to travel over land that has already been overgrazed and, finding water but no forage, have literally starved at the water holes.

The sedentary farmers in the south of the Sahel have been no better off. Some were tempted to move into the marginal, dryer, more northern areas and others began to devote their efforts to cash crops, cotton, and peanuts rather than food grains, millet, and sorghum. These changes, along with a rapid increase in population, have forced an increased intensity of land use such that fields formerly cultivated two years out of 20 must now be used two years out of 10 in order to support all the villagers.

It is this widespread overuse that is preventing the land from recovering even when rain does fall. Instead of being absorbed, the rain falling on the vegetation-stripped ground merely washes off the topsoil. The cycle—over-grazing, wind, rain—is causing the desertification of much of the land.

The conclusions of the M.I.T. Sahel-Sudan group are theoretically simplistic, complex in practice. Agricultural efficiency must be improved, they say. The herds would be more productive if fewer animals were in competition for the limited resources. But in the Sahel cattle are money, a commodity to be sold or traded as needed, on-the-hoof savings accounts that people are not willing to give up.

More modern methods of agriculture—mechanized equipment and fertilizers—would increase production. But modern agriculture also means larger farms, more machines, and displaced people. In this region of West Africa there is no industry to provide jobs for displaced farmers, and because of the high cost of labor and the lack of skilled workers, none is in sight.

The Sahel-Sudan study recommends, in part, that the processing of peanuts and cotton be incorporated into the local economies. The report also suggests cooperation between the northern and southern regions in terms of cattle breeding and raising.

In the Sahel the insurmountable fact is that there is no surplus of natural resources of any sort to capitalize upon. The situation, says Dr. Seifert, is "pretty grim."—*S.J.N.*

S.S.T.: Doubts Confirmed

Congress defeated the S.S.T. prototype program on a wave of public, emotionally charged wrangling. Now the evidence is in, and the climatological concern which may have seemed farfetched three years ago is in fact justified. A fleet of approximately 1000 S.S.T.s flying eight hours a day would indeed destroy a measurable percent of stratospheric ozone.

Concentrated in a layer from 10 to 20 miles above the earth's surface (the S.S.T. flying corridor), ozone—a three-atom molecule of oxygen (O_3) formed by the action of sunlight on molecular oxygen (O_2)—protects the earth from the sun's ultraviolet radiation. A reduction of the concentration of ozone would allow an increased and possibly harmful amount of ultraviolet radiation to reach the earth's surface, affecting plants and animals alike.

S.S.T. exhaust contains nitric oxide (NO), which reacts with ozone to form molecular oxygen (O_2) and nitrogen dioxide (NO_2). In turn, nitrogen dioxide reacts with oxygen to form nitric oxide (NO) and molecular oxygen—a catalytic chain reaction that could continue indefinitely.

To discover the cumulative effect of continued emissions of nitric oxide and the extent of their dispersal by stratospheric winds, two members of the M.I.T. Department of Meteorology, Derek M. Cunnold and Fred N. Alyea, created a three-dimensional mathematical model of the upper atmosphere. Theirs is the most extensive such model yet contrived, taking into consideration altitudes up to 70 kilometers as well as global latitudinal and longitudinal representations. Their model was initially verified by comparing ozone predictions against the observed amounts of ozone presently in the stratosphere and adding a projected amount of NO emissions for the year 2000 (about 1.8 megatons a year) from a fleet of S.S.T.s

Their findings agreed remarkably with the projections made three years ago, when very little information about the stratosphere was available. Hypothesizing an S.S.T. traffic pattern in a corridor between 40 and 50 degrees latitude in the northern hemisphere, they found that ozone was depleted there by 16 per cent. But they also found ozone was depleted by eight per cent in the southern hemisphere, although no S.S.T. flights were assumed south of the equator. Depletion of ozone rose to 20 per cent north of the flight corridor, apparently because of a blocking effect of the NO upon the transport of ozone by high altitude winds.

The authors suggest that this level of ozone depletion could have environmental effects on earth, and that their data suggest the need for a global network to monitor the levels of stratospheric pollution. The authors note that a yearly limit of 0.1 megatons of nitrogen oxide discharged into the stratosphere would result in the destruction of less than 1 per cent of the atmospheric ozone.

"Monitoring is a difficult problem," says Dr. Cunnold. "We don't yet know enough about the observed atmosphere to determine whether changes in ozone levels are natural or related to pollutants."—*S.J.N.*

Pollution from the Streets

A modern city's watershed may be more polluted by rain than by sewage.

As sanitary sewage treatment becomes the rule instead of the exception in the U. S., attention begins to focus on the second major urban pollution source: the runoff from streets, parks, lawns, and buildings. Indeed, according to Robert E. Pitt of Woodward Envicon, Inc., and Richard Field of the Environmental Protection Agency, rain runoff may now contribute more pollution than sewage from many modern cities.

In a case study reported to the American Water Works Association annual convention in Boston this summer, the two engineers found that raw stormwater contained five times as much pollution (in terms of its demand for oxygen in chemical reactions—the chemical oxygen demand) as treated sewage in Durham, N. C.; the demand for oxygen in biological reactions (the biological oxygen demand) was three times greater. Storm runoff contained five times as much phosphate as treated sewage, and it contained large amounts of heavy metals, notably lead and zinc.

In the course of a year, think the two engineers, storm runoff from Durham may contribute 55 tons of phosphates, 34 tons of lead, and 7 tons of zinc to the rivers into which it drains.

The effect of oxygen depletion is well understood, and there are records of fish kills in many rivers following heavy rains. But far less is known about what the engineers call the "exotic" pollutants—the heavy metals. In the short term, such pollutants are less serious in hard water than in soft; but in the long term, irrespective of water characteristics, they may well gradually concentrate to toxic limits in local ecosystems.

Two solutions:

—Better street cleaning. Most present street cleaning programs and equipment were designed with "no awareness of the significant polluting effects of stormwater runoff," said the engineers. But effective, daily sweeping of streets would "achieve removal rates close to those needed."

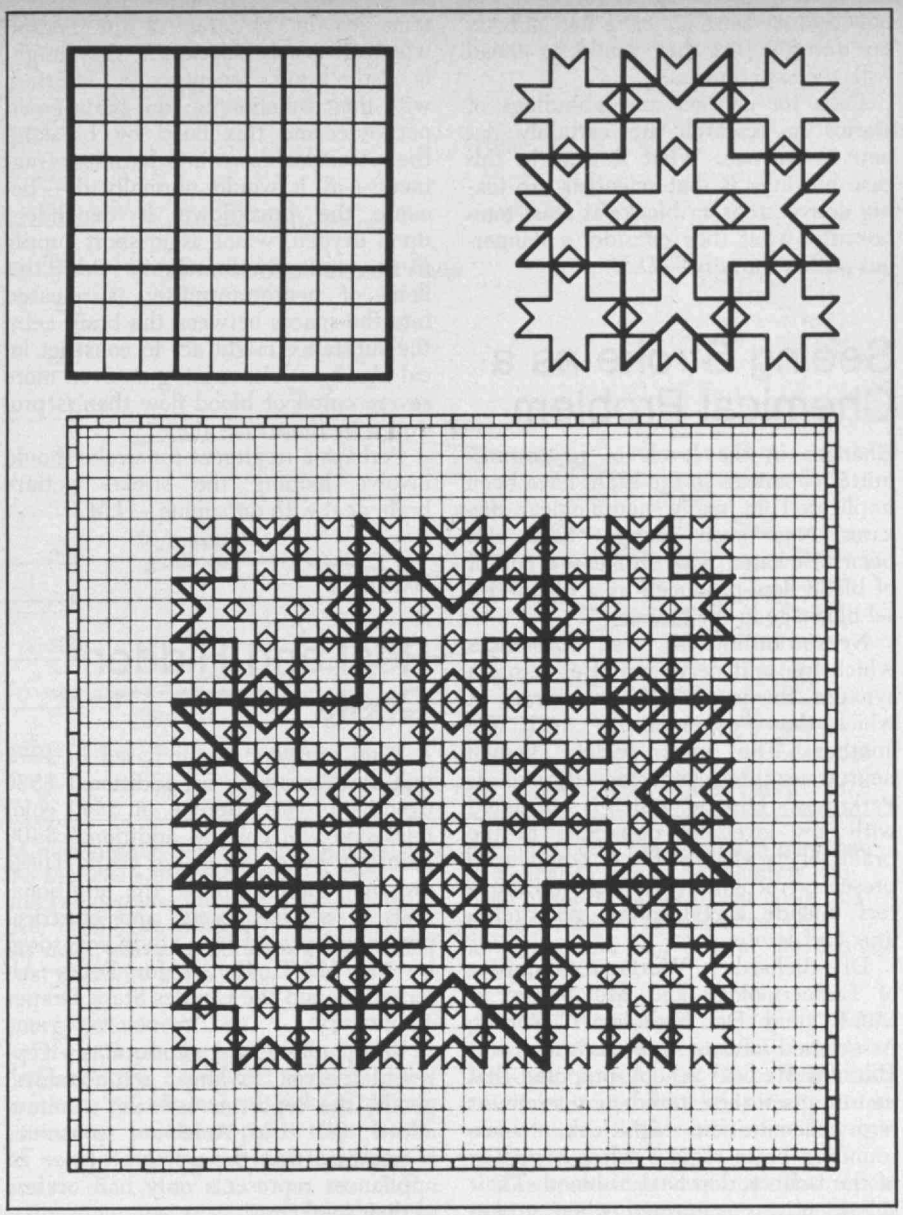
—Stormwater sewage treatment. Because runoff comes in surges after heavy rains, the problem of most cities is to build storage facilities to hold the polluted stormwater until it can be accommodated in existing treatment plants. At $10,000 per acre, this works out for most cities to be more than the cost of daily street cleaning. And daily cleaning offers the additional advantage of eliminating some toxic materials which are not easily dealt with in conventional water treatment. —*J. M.*

EDUCATION

The Music of the Squares

Every child is an artist, drawing "perseveringly and passionately." But when entering school, a child is forced to graduate from free-hand drawings to the geometrical ones which teach the fundamentals of arithmetic, representation, perspective, and eventually plane geometry. And the spirit of originality which first motivated the drawing is lost: the geometry "does not often appeal to the eye, to the soul, and to the spirit," thinks Reinhard Lehnert, a German artist/mathematician/teacher.

Mr. Lehnert has an alternative: a system of layered, two-dimensional geometrical exercises which he thinks offer motion, excitement, and special educational value. Think of the simple grid in the top left drawing on this



These drawings, and hundreds of modular extensions building on the system they demonstrate, are the result of a concept of layered geometrical pictures to be created by children who want to explore the subtle, powerful precision of geometry. The system, which is described briefly by the story below (*see "The Music of the Squares"*), is proposed to give its users "the opportunity of making innumerable little geometrical 'discoveries' independently, and of creating work which is geometrically and aesthetically perfect." (Drawings copyrighted by Reinhard Lehnert, used by permission)

page as composed of three superimposed layers: the single large square is one layer, the nine bold squares (3×3) are a second layer, and the 81 small cells (9×9) are a third.

Now make some simple changes in each layer: substitute for the square of layer 0 a rhomb, for the 9 squares of layer 1 in the same way 9 rhombs, for the 81 squares of layer 2 in the same way 81 rhombs. Superimposing the layers, you now have the center drawing directly above.

Add more layers and repeat the process, and you come to the large drawing—which is only the beginning of the possibilities of this system of geometrical pictures to be drawn by students on paper. If different colors are used in different areas on various layers, still more variety is possible.

But beyond aesthetics, thinks Mr. Lehnert, his system is important because it "replaces the authority of the teacher by that of the object," and students soon enough "become fascinated by the vivid experience of the mathematical accuracy of the pictures and by their inner accordance."

Fully developed, Mr. Lehnert finds that his system even makes possible a "visual music . . . an art derived from abstract films, which offers to the eye what tonal music offers to the ear."—*J.M.*

Self-Regulation Among Biologists

In the science fiction movies of the 1950s it seemed that the last scene invariably featured the fiery destruction of the monster-run-amok with our hero turning to a fellow and saying "Mankind is just not ready for such knowledge."

Echoes of this sentiment were heard in the scientific community—perhaps for the first time in scientific history—with publication of a letter from eleven prominent biologists calling for the postponement or cessation of a very promising line of scientific inquiry.

In the letter published in July issues of the scientific journals *Science* and *Nature*, the scientists requested that their colleagues refrain from certain genetic experiments because of the possibility that they might unleash semisynthetic microorganisms that could cause epidemics, be resistant to antibiotics, or increase the incidence of cancer.

Among the scientists were Dr. David Baltimore of M.I.T., one of the discoverers of the viral enzyme reverse transcriptase, a key link in explaining how viruses might cause cancer; and Dr. James D. Watson, co-winner of the Nobel Prize for his elucidation of the structure of DNA.

The letter was a personal plea for restraint from the members of a National Academy of Sciences Committee on Recombinant Molecules, headed by Dr. Paul Berg of Stanford University.

The experiments to be restricted have been made possible by recent advances in techniques for isolating and rejoining segments of DNA using enzymes known as restriction endonucleases. The experiments consist basically of using the enzyme to snip off specific genes in one organism and introducing those genes into the genetic material of a different organism to see how they function. Such experiments would enable scientists to discover much about the action of certain genes without interference from other genetic material of the organism from which they came.

The technique also raises prospects of genetic engineering—perhaps using the enzyme to replace faulty genes in humans with functioning ones. The scientists called for the deferment of two basic types of the experiments:

—introducing into bacterial DNA a gene for resistance to an antibiotic to which the bacteria is not ordinarily resistant, or introducing genes for toxins which a bacterium cannot ordinarily make.

—the linkage of DNA from cancer

viruses or other viruses, to DNA in bacteria or other viruses. Such recombinant DNA molecules might spread to bacteria in humans, possibly increasing the incidence of cancer.

Although they did not ask for a ban, the scientists urged caution in a third experiment, introducing animal DNA into bacteria, because many types of animal DNA contain elements of cancer viruses.

They said a potential hazard in current experimentation arises from the common use of the bacterium *Escherichia coli*—a resident of the human gut—as a recipient of DNA snippets from other organisms. If a mutant form of this usually harmless bacterium escaped, it could thrive and possibly exchange genetic information with harmful bacteria, with unpredictable results.

The scientists stressed that they base their plea only on potential risk, and not demonstrated danger. Nevertheless, they feel that the results of the genetic experiments could produce microorganisms inherently more dangerous than those used as biological warfare agents.

Such germ warfare bacteria are themselves quite dangerous, but have been designed not to be contagious. They are either animal diseases applied to man (e.g., anthrax) which would not be transmitted between humans, or they are diseases which require a particular carrier for transmission, such as a mosquito or tick (e.g., Rocky Mountain spotted fever). And such biowar weapons, made as they are from naturally occurring organisms, are usually held in check by natural immune defenses.

But this is not necessarily so with the microorganisms receiving dangerous genes from another species.

Thus, the scientists asked that the National Institutes of Health establish procedures to evaluate possible hazards from such experiments, and develop safeguards to prevent the spread of possible hazardous organisms.

Although Dr. Baltimore and his colleagues at M.I.T. have not performed any such experiments, they had outlined and planned them after the enzyme techniques were developed.

"We had planned to cut up the DNA copies of RNA tumor virus genomes and isolate them by introducing them into *E. coli*," said Dr. Baltimore. "However, after we had considered the experiments carefully, we decided that we could not do them without the hazard of introducing the genes into the environment. It was then that we began discussions about the need for restricting such experiments.

"Reactions obtained before and after publication of the letter lead us to believe that the postponement will be honored. At least we have had nobody say outright that they would go ahead with the experiments."

Calls for caution and soundings of alarms in research are certainly not new to science. What is new in this case however is that scientists are taking active steps to block, at least temporarily, what they consider a dangerous path of inquiry.—*D.M.*

Seeing Stroke as a Chemical Problem

Changes in the levels of neurotransmitter chemicals in the brain have been implicated in many neurological diseases. Now such changes have also been associated with strokes—a cut-off of blood flow produced by a blood vessel blockage in the brain.

Neurotransmitters are substances which transmit nerve impulses across a synapse, the point between neurons at which they "communicate" with one another. The most widely known neurotransmitter-connected disease is Parkinson's Disease, which is associated with low levels of dopamine in the brains of its victims. Other compounds presently recognized as neurotransmitters include acetylcholine, noradrenaline, and serotonin.

Dr. Richard J. Wurtman, Professor of Endocrinology and Metabolism at M.I.T., and Dr. Nicholas T. Zervas, Associate Professor of Neurosurgery at Harvard Medical School, proposed that neurotransmitters stored in neurons at high concentrations might leak into surrounding brain regions when a portion of the brain is deprived of blood. Their suspicion was confirmed when strokes were simulated in six squirrel monkeys by cutting off the blood flow to the left middle cerebral artery. Dopamine was found in the left hemisphere in concentrations only about half as great as in the animals' undamaged right hemisphere. These results were later confirmed by work on the Mongolian gerbil.

Dr. Wurtman believes these findings represent "the first evidence of a change in neurotransmitter level accompanying a cutoff of blood to the brain." He admits that the findings, reported in *Nature* and *Journal of Neurosurgery*, are only fragmentary. But Dr. Wurtman thinks they "suggest a promising pathway to follow in studying the effects of stroke. . . . Since there are numerous drugs that we know affect the levels of dopamine and other neurotransmitters, these findings suggest excellent opportunities for treating or preventing some stroke damage."

For example, suppose a stroke leads to release of dopamine into the bloodstream in the brain. If these molecules remained in the area of the neuron which they normally affect, they might flood the brain's receptors and interfere with their functioning; the brain could not overcome this flood by breaking the molecules down into harmless fragments—as it would normally do—because the breakdown is dependent upon oxygen, which is in short supply in the stroke victim's brain. Or if this flood of neurotransmitter is released into the spaces between the brain cells, the substance might act to constrict local blood vessels, causing an even more severe cutoff of blood flow than is produced by the stroke alone.

Perhaps a treatment for stroke should involve helping the stroke victim's brain deal with dopamine.—*J.M.*

MATERIALS

Real and Hidden Costs

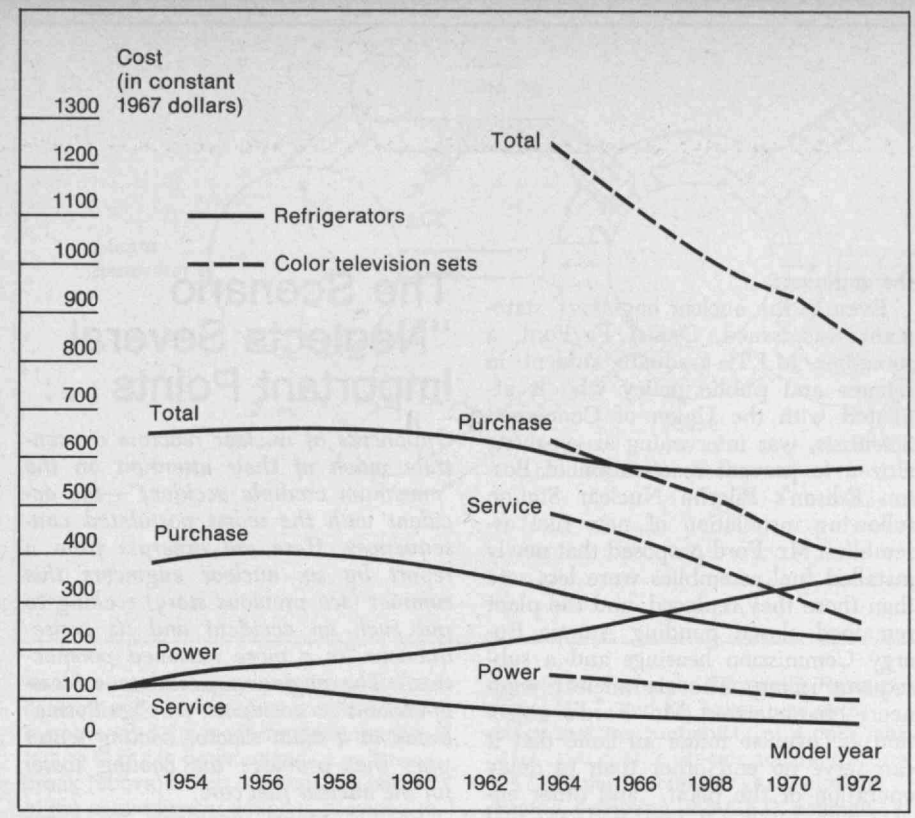
A $300 refrigerator purchased in 1972 will cost its owner an additional $530 over its 14-year lifetime. A $400 color television will cost an additional $400 before it wears out in ten years. These are the "hidden costs," the additional costs of service, parts, and electrical power, uncovered by a study sponsored by the M.I.T. Center for Policy Alternatives and the Charles Stark Draper Laboratory.

Using these two products as representative of "white" and "brown" goods, the report issued this summer added that the American consumer is unaware that the purchase price of appliances represents only half or less of their total cost.

Innovations in color television in the last 20 years have reduced the electricity requirement to 12 per cent of its total cost, and there does not appear to be much room for improvement. But while full-year warranty competition has reduced the average number of service calls from six per year to one, the savings in dollars has been offset by increases in labor costs, so the cost of servicing has declined only slightly.

In contrast, innovations in refrigerators over the last 20 years (increased size, and such improved features as frost-free freezers) have been energy-intensive. While the average cost of refrigerators has dropped about $50 in the last ten years, the cost of power has increased to 58 per cent of the total cost.

Since "the cost of electrical energy promises to become an increasingly important concern both nationally and for the individual consumer," some specific suggestions to manufacturers were made by the study to improve



As measured in constant 1967 dollars, the real costs of color television sets and refrigerators have declined slightly over time. In its average 10-year life, the color television purchased today will cost its owner about $800, twice the purchase cost. The decline in purchase and service costs of refrigerators has been offset by higher power costs due to the increased convenience, performance, and unit size of the average refrigerator.

energy efficiency:

—Discontinue the use of fiberglass as insulation in favor of foamed polyurethane to reduce heat leakage. While increasing purchase price, this tradeoff would create a savings in life-cycle costs.

—Improve the operating efficiency of the electric motor by using more copper or aluminum, another increased initial cost that would net a 5 per cent savings over the life of the refrigerator.

The study offered the consumer no hints as to how to pressure the appliance industry for power efficiency or increased warranty length, but did suggest that the consumer should be aware that the purchase cost is only part of the total cost of an appliance, try to find out the comparative power and service costs, and buy accordingly.—*S.J.N.*

Roofing: Ending a Ceiling on Housing

Considering all the problems of underdeveloped countries which are weighed by developed countries—whether for benevolent or selfish motives—who ever thought of roofing?

Your mistake.

For housing is "the most complex problem" for most developing countries, and "the most serious obstacle to low-cost housing in the developing countries, regardless of setting or sophistication, is the lack of a low-cost roofing material."

The quotations are from the report of an advisory committee to the Building Research Advisory Board published this summer by the National Academy of Sciences. Albert G. H. Dietz, Professor of Building Engineering, Emeritus, in the M.I.T. School of Architecture and Planning was its Chairman, and the committee included housing and building experts from industry, the World Bank, the United Nations, and two developing countries.

After a year of work, the committee concluded that there is no ideal roofing material for a developing country today, and a low-cost, high-performance system—including both supporting structure and roof itself—"could significantly accelerate the production of more and better housing." A real research opportunity, thinks the committee: there is enough unrealized potential in existing materials so that research on "fresh approaches . . . is likely to be productive at this time."

What materials? Low-cost, simple, and indigenous—vegetable, animal, and mineral—durable, strong, and safe. Plastics for binding vegetable fibers such as thatch, earths, or fabrics; foamed plastics produced on-site in various forms; sulfur as a binder for indigenous materials; binding resins from agricultural wastes; such industrial wastes as fly ash and "red mud"—"a copious by-product from bauxite refining that gluts many developing countries"; concrete and clay.

In summary—"numerous promising avenues of exploration."—*J.M.*

Floating Zinc in Fluid Iron

At least 5 million automobiles are scrapped by shredding machines annually in the U.S. From them comes a stream of reusable ferrous scrap and a residue of nonferrous material which is typically dumped after simple scavenging to recover the valuable copper.

But in the nonferrous fraction are significant amounts of zinc (perhaps 40 lbs. per shredded car), aluminum (10 lbs.), unrecovered copper (5 lbs.) and stainless steel (2 lbs.)—at least $10 worth from a typical automobile. Now Leon Mir of AVCO Systems Division and two colleagues—C. Simard of AVCO and D. Grana of N.A.S.A.'s Langley Research Center—propose that "ferrofluid levitation" can retrieve most of the nonferrous fraction at a cost low enough to be practicable.

The separation process they propose is based on an unusual property of ferrofluids, which are stable colloids of small magnetic particles suspended in a fluid. Such a ferrofluid in a magnetic field will float a nonferrous object of far greater density than that of the fluid.

The action is simple enough. A vertical magnetic field through the ferrofluid has the effect of increasing the fluid's density; hence the floating effect. By regulating the strength of the field, the nonmagnetic can be made to float or sink; and if you have two nonmagnetic materials in a single ferrofluid, the magnetic field can be manipulated to float first one and then the other.

Additional processing is required before the ferrofluid process can work effectively on nonferrous shredding machine scrap. The scrap must be ground into finer pieces, remaining magnetic material must be removed, and lightweight material must be eliminated so it does not absorb the ferrofluid. But preliminary AVCO studies, sponsored by N.A.S.A. and reported last fall at the Third Urban Technology Conference in Boston, suggest that an additional investment for magnetic fluid levitation systems—perhaps $360,000 for a plant handling 300 cars/day—would pay for itself in three years; larger plants would return their capital cost even sooner.—*J.M.*

Six Advocates of Nuclear Power

Despite heated, sometimes bitter, controversy over nuclear power plants, engineers and government officials alike have now generally concluded that nuclear power is the safest, most dependable way to meet growing demand for electricity and energy between now and at least the year 2000.

Concerned about the deteriorating quality of the public debate over nuclear power, six nuclear engineers—all graduates of M.I.T.'s Department of Nuclear Engineering—joined during the summer to issue what they described as "a call to reason": End the scare tactics and the overreaction to problems and shortcomings still associated with nuclear power. They contended that for the next 25 years "our only feasible methods for generating electricity are coal, oil, and nuclear power" and that of these "nuclear power is more than acceptable—it is preferable.

"A call for a nuclear moratorium is without merit," they wrote.

The six authors are Gilbert J. Brown, Ian A. Forbes, Marc W. Goldsmith, Andrew C. Kadak, Joseph P. Kearney, and Joe C. Tunage. Dr. Forbes, who is Chairman of the Department of Nuclear Engineering at Lowell Technological Institute, was their chief spokesman; he was an original member of the nuclear study group of the Union of Concerned Scientists but has since rejected that organization's approach and many of its findings.

The engineers admit that public advocacy movements have raised many important questions about nuclear power and that as a result "many gains have been made toward greater guarantees of nuclear plant safety." And the job is not yet done; reliability can be further improved, and the problem of ultimately disposing of high-level wastes from nuclear reactors is unresolved. But "scare tactics," factual errors, and irrational charges by such advocates as Ralph Nader and the Union of Concerned Scientists have now made "reasoned debate" almost impossible; their efforts have now deteriorated to become "an attempt to force the public to make a decision on nuclear power without the benefit of the best information available on the subject," said the engineers.

Even as the nuclear engineers' statement was issued, Daniel F. Ford, a sometime M.I.T. graduate student in science and public policy who is affiliated with the Union of Concerned Scientists, was intervening as a private citizen to prevent reactivation of Boston Edison's Pilgrim Nuclear Station following installation of new fuel assemblies. Mr. Ford proposed that newly installed fuel assemblies were less safe than those they replaced, and the plant remained closed pending Atomic Energy Commission hearings and a subsequent ruling. The six nuclear engineers characterized Mr. Ford's objection as "over so minor an issue that it can serve no end other than to delay operation of the plant," and other engineers pointed out that the new fuel elements, being smaller, in fact operated at a lower temperature and were better protected against physical deterioration. The engineers' judgment was vindicated by mid-summer when the A.E.C. permitted Pilgrim to reopen. Boston Edison said the closing forced it to burn oil worth $9 million a month which would otherwise not have been needed; this cost was passed on to consumers as fuel adjustment charges under Massacusetts law.

Here are details of the nuclear engineers' arguments in favor of nuclear power:

—The "maximum credible accident" postulated for a nuclear reactor (*see following story*)—the so-called "loss-of-coolant" accident—is remote and its consequences no worse than those of a similarly-postulated major accident in an oil-fired plant; indeed, the risks are "comparable to, or less than, many other natural or technological risks to human life."

—The public health risks associated with normal operation of power plants—air pollution from fossil fuel combustion and radioactivity from nuclear reactors—are modest at worst, and of these "nuclear power poses the smallest hazard."

—The environmental impact of nuclear power is far less than that of coal-fired power and not significantly more than that of oil-fired generation.

—Considering fuel supplies and probable future prices, "nuclear power is the most economic bulk electricity supplier."—*J.M.*

The Scenario "Neglects Several Important Points . . ."

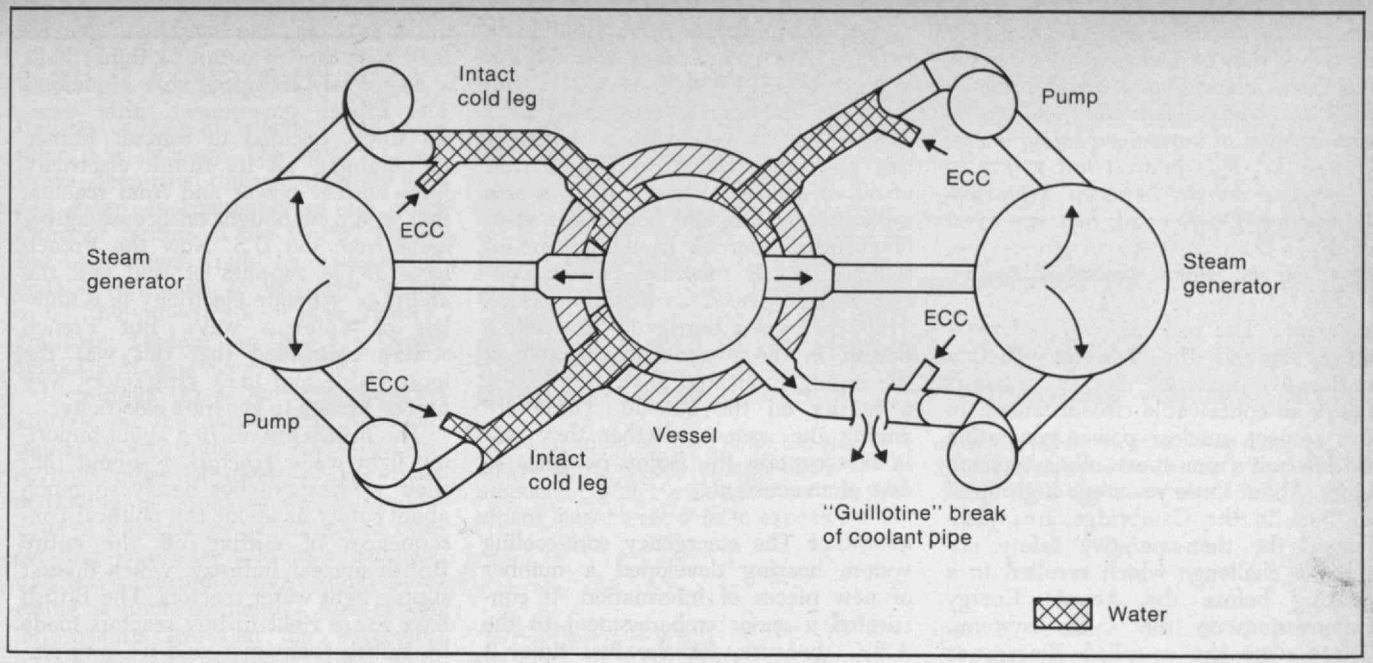
Opponents of nuclear reactors concentrate much of their attention on the "maximum credible accident"—the accident with the worst postulated consequences. Here are excerpts from a report by six nuclear engineers this summer (see previous story) seeking to put such an accident and its consequences "in a more reasoned perspective." The engineers postulate a "loss-of-coolant" accident—a "guillotine" break in a main reactor cooling water pipe that provides the cooling water for the nuclear fuel core.

For a major accident to occur through loss of coolant, a main reactor cooling water pipe (36 in. diameter, with walls 3½ in. thick) must not just crack or split open, the way that a pipe would generally be expected to fail. It must actually break cleanly all the way around (a so-called "guillotine break") with complete separation of the broken ends. Because nuclear piping is designed to high seismic (earthquake-resistant) and stringent quality standards, it is highly unlikely that a crack or split would occur, and even less likely that a guillotine break would occur.

If such a break should happen, the . . . reactor vessel would lose pressure as water poured out of the break. The cooling water in the vessel would turn to steam, leaving the nuclear fuel without an adequate cooling medium. This situation could lead to melting of the radioactive fuel *unless* some alternative means of cooling is provided.

The much-discussed Emergency Core-Cooling System (E.C.C.S.), intended to provide several backup supplies of cooling water to keep the fuel from melting, has been the object of heated controversy centering on the fact that there have been virtually no actual tests of this system under realistically simulated accident conditions. The LOFT (Loss of Fluids Test) reactor in Idaho Falls will be used to conduct the first true integrated experimental test of the E.C.C.S., but will not be ready for operation until mid-1975.

As a result of the recent hearings, the Atomic Energy Commission's design regulations for the Emergency



To question the safety and dependability of nuclear power reactors analysts have hypothesized the most dramatic reactor failure that can be imagined: a guillotine break (above) which deprives the reactor of the cooling water which is provided to control temperatures and assure integrity of the reactor core if some other episode permits the core to overheat. In their exhaustive study of reactor safety (see pp. 14-15), Professor Norman C. Rasmussen of M.I.T. and his colleagues determined that the probability of a core melt-down from such a reactor accident is one in 17,000 per reactor per year; with 100 reactors operating (the A.E.C. estimate for the U.S. in 1980), that means one such accident might occur, on the average, every 170 years.
But dependability in nuclear reactors remains elusive. Almost half of the 50 power reactors now in use in the U.S. will have been shut down for part of the last three months of this year to check for cooling system cracks which have been found in three reactors, and there have been a host of other frustrations for nuclear plant owners and builders.

Core-Cooling Systems have been made more stringent, and the computer codes used for design have become much more sophisticated. In addition, nuclear reactors are now using fuel rods that are smaller and more easily cooled than those previously used. It is our opinion that the E.C.C.S. can reasonably be expected to operate effectively and prevent the nuclear fuel from melting in the unlikely event of a "loss-of-coolant" accident. However, without experimental verification, which the LOFT reactor tests should provide, it is likely that the public will remain skeptical of the ability of the E.C.C.S. to prevent the nuclear fuel from melting.

So let us *suppose* that the E.C.C.S. does *not* work and follow the subsequent course of the postulated accident. If the radioactive fuel is left uncooled, it will melt and slump to the bottom of the steel pressure vessel, melt through the vessel and fall into the concrete foundations below. It is at this point that a number of people have postulated (not calculated) a situation where the molten nuclear fuel, in one *single* lump, sinks into the earth below the power plant and then releases *all* its gaseous and volatile radioactivity back up through the earth and into the atmosphere. Then, assuming the winds carry all this radioactivity off to the nearest city, deaths in excess of 100,000 have been "predicted."

This frightening scenario neglects several important facts (*other* than the fact that the likelihood of a guillotine pipe break followed by failure of the E.C.C.S. is extremely small). The first is that the molten nuclear fuel is more likely to disperse in the concrete and rock under the reactor than to sink down as a single mass. This means that the fuel would melt only a short distance into the concrete foundation of the plant or the earth beneath. Secondly, the radioactivity, in the form of a gas, is more likely to return to the containment building in which the reactor and its pressure vessel are housed, along the holes created by the melting fuel, than to create new paths out into the atmosphere. Thirdly, the earth has an excellent capacity for absorbing all but a few of the gaseous and volatile radioactive materials that would be released (noble gases are virtually the only exceptions).

A large percentage of the dangerous fission products that return to the containment would attach themselves to the surfaces in the containment, never to reach the public. Those that are trapped in the earth under the plant would take decades to migrate away from the plant site—ample time to assure the protection of the public from the small amount of radioactivity still remaining.

All of this implies that in the highly unlikely event of a melt-down of the nuclear fuel, only a small fraction of the radio-activity in the fuel could be expected to escape into the atmosphere. . . . Hence, rather than the figure of 100,000 deaths due to a nuclear accident which some people have "predicted," it would seem to be difficult to determine any sequence of events, however improbable, that could lead to (more than) 1,000 to 5,000 deaths (both immediate and long-term)

While those numbers may still seem high to some (however remote the risk), . . . they may be no worse than the consequences of a major accident in an oil-fired plant and comparable to, or less than, many other natural or technological risks to human life.

"We're Looking at Everything That Happens . . ."

Norman C. Rasmussen, Professor of Nuclear Engineering at M.I.T., has spent much of the last 24 months directing an intensive study of nuclear reactor safety for the Atomic Energy Commission (see *Technology Review* for March/April, p. 7). *Meanwhile, Henry W. Kendall, Professor of Physics*

who is identified with the leadership of the Union of Concerned Scientists, has been advocating a moratorium on nuclear reactor construction and operation because of unresolved safety issues. Hence the wide interest last spring in a campus debate between Professors Rasmussen and Kendall; here are some excerpts from their discussion as prepared by the Atomic Industrial Forum:

KENDALL: The real safety question revolves around the issue of whether radioactive material can be retained under all conceivable circumstances. In this respect, nuclear power generation is different from most other technologies. About three years ago a group of us here in the Cambridge area challenged the then-operative safety criteria, a challenge which resulted in a hearing before the Atomic Energy Commission on the safety systems. These were the so-called Emergency Core-Cooling System (E.C.C.S.) hearings, and they went on for some two years. . . . We believe we've had an unparalleled opportunity to investigate the safety program.

RASMUSSEN: We're concerned about the 1,000 megawatt plant. There are about 10^{10} curies of radioactivity in the core when the reactor is operated, and were any substantial fraction of that to be released, there would be a serious accident. Now the fuel of a nuclear reactor of the kind we build today is uranium dioxide. That's a ceramic material that melts at 5,000°F. It has the property of containing within it essentially all the fission products except for the few gaseous and highly volatile products that leak out during the operation.

The real hazard we're concerned with in terms of major risks is the melting of the core, because only if the core is molten will a substantial fraction of the radioactivity be evolved from the core. The parts of the reactor include the fuel rods which are 0.75 in. diameter, 12 ft. long and contain a lot of little pellets of uranium dioxide. These are sealed to contain their radioactivity. They are placed together to form a core of many thousands of rods which is 12 ft. long and 12 ft. diameter. That core is surrounded by a pressure vessel of steel, typically six to ten in. thick, which contains the water that flows up through the core and out.

The water comes in at a temperature of about 550°F. and goes out at a temperature of about 600°F., and is at a pressure somewhere between 1,000 and 2,200 lbs./in.^{2}, depending upon the kind of reactor. The water is either steam or hot water converted to steam when it comes out; this drives the turbine and generates the electricity.

Keep in mind how big a 1,000-Mwe plant is. For comparison: a coal-burning plant of 1,000 megawatts consumes 10,000 tons of coal a day or 3 million tons a year. An oil plant of this size consumes 12 million barrels of oil, or enough to heat a quarter of a million New England homes per year. One further barrier to the escape of radioactivity is provided by the container shell placed around the vessel. Thus we have a barrier in the clad; a barrier in the pressure vessel and in the piping connected to it; and finally, a barrier on the outside. Those are among the issues—whether they will in fact contain the fission products in case of an accident.

KENDALL: The emergency core-cooling system hearing developed a number of new pieces of information. It constituted a major embarassment to the A.E.C. because, for the first time, it publicly gave evidence of major gaps in knowledge of the behavior of the emergency systems which are designed to restore water to a core in the event of a pipe rupture. There has been no major melt-down and no massive release of radioactivity so far, but this is no assurance for the future. We were leaked a Safety Review prepared by the Regulatory Division of the A.E.C. which said that the reactor program was besieged, in their words, with various safety problems. It was said that approximately 850 abnormal occurrences were reported to the A.E.C. during a 17-month period used as a sample base [January, 1972, to May 30, 1973]. These abnormal occurrences involved malfunctions or deficiencies associated with safety-related equipment. Forty per cent of the occurrences were traceable to some extent to possible design and/or fabrication-related deficiencies. The primary cause of at least 200 of the component malfunctions was design and/or error, improper maintenance, administrative deficiencies, random failure, and variations of the foregoing. Many of the incidents had broad generic applicability, and potentially significant consequences.

The most important review has been carried out in the United Kingdom. Because of Britain's grave energy problem there has been great pressure to purchase 26 American nuclear reactors. British experts have indicated deep concern over the possibility of pressure vessel rupture, E.C.C.S. weaknesses and certain failures in shutdown mechanisms. In aggregate, the information was in my view equivalent to saying the devices were too hazardous to install in Britain.

RASMUSSEN: Professor Kendall claims that, outside of a few people who build reactors, the world in general feels that they're unsafe. I think that's a completely unsupportable argument. The French government, after careful study, decided to commit France to obtaining all its future electricity from nuclear power and from reactors that would be bought on license agreement from the U.S. Now the French have ample supplies of coal and the ability to generate electricity in a number of different ways. But French studies concluded that this was the most viable and most satisfactory way for the French to generate electricity.

The British are worried about importing light water reactors. I submit that their worries are not nearly so much about safety as about the political consequences of cutting off the entire British nuclear industry, which doesn't supply light water reactors. The British have every right to buy reactors made by British companies, and it's very embarrassing to buy them somewhere else.

° ° °

I'd like to comment on Professor Kendall's comments about the A.E.C. Regulatory Division study. That study was done to see in what areas the Division might further concentrate its efforts. The report pointed out that 850 incidents that involved parts of the safety system in nuclear plants had been reported. I've read those 850; they come out in stacks every month. They have to do with valves failing, relays sticking, all kinds of failures that we expect in engineered systems, no matter how well made, the kind of things that we design the plant to accommodate. And I submit that the list is not a bad comment on the A.E.C. but a good one. It means that we're looking at everything that happens in these plants, publishing it in the open record, and learning from this experience. Because these kinds of failures are being reported to everyone and pointed out to everybody, fewer incidents will occur.

Probably 25 per cent of the investment in a nuclear plant is in systems that never operate and probably never will operate in the course of a plant's life except for testing. The general design philosophy is to make the equipment so that it will not fail. But then we put into these plants what we call protection systems, whose sole function is to detect any abnormal operation and automatically either trip the reactor or alert the operator. We further put in a series of engineered safety features whose sole purpose is to ameliorate the consequences of a very rare and very unlikely event such as the double-ended break in the largest piping system. We do all that, and I contend that these plants have a very good safety record and that the margins of safety are quite adequate.□

Call It Calamari

Italians call squid *calamari* and consider it a delicacy. On Spain's Costa Brava, deep-fried rings of squid are sold and eaten as commonly as are fried clams or oysters in the United States. But here "there would be considerable market resistance to anything called squid," hypothesizes Paul H. Kalikstein, graduate student at M.I.T.'s Sloan School of Management.

In addition to a generally negative attitude on the part of the American public toward squid, Mr. Kalikstein uncovered other obstacles to the mass marketing of squid in the U.S.: The costs of processing—skinning and eviscerating—must be held to a competitive level (currently most squid processing is done by hand). And fishing industrialists feel that the "successful introduction of a processed squid product would be impossible," holding the opinion that even a huge advertising outlay (impossible for this beginning industry) would have little effect on consumer attitudes.

Despite these drawbacks, squid's potential as a foodstuff in the U.S. is vast. According to Zeki Berk, Professor of Food Science at M.I.T., this close relative of the oyster and clam is "probably the most abundant of the underutilized species of marine food animals."

Only 10 per cent of the ocean's surface is presently fished for squid. With full exploitation Dr. Berk estimates the possible squid harvest at 100 to 500 million tons per year. Since 70 per cent of the squid can be eaten, even a catch of 300 million tons represents over 200 million tons of food containing 18 per cent protein.

The positive factors of availability, low-cost quantity catches, and food value could tip the scales in favor of squid. Surveys and taste tests conducted by Mr. Kalikstein showed that it is not the flavor of the squid that Americans object to, but its unfamiliarity as food and slimy-sounding name. By preparing squid to be used as are more familiar seafoods—canned like shrimp, for example—it could be made to appeal to conservative American tastes. And the processing difficulties may be close to resolution: Dr. Berk has invented a simple automatic skinning and eviscerating machine that could be adapted for industrial purposes.—*S.J.N.*

Cleaning squid by hand is far too slow and costly a process for large-scale production. Both the skin and the internal organs must be removed to expose the mantle's edible muscle. Once cleaned, the nutritious mantle can be prepared and eaten as are shrimp or clams.

Plenty of Food — With Some Gaps

Is the world really running out of food? Two apparently divergent answers:

—From Don Paarlberg, Director of Agricultural Economics at the U.S. Department of Agriculture, paraphrasing an unpublished report of the United Nations Food and Agriculture Organization prepared for the 1974 World Food Congress: though it is too early to know the results of the 1974 harvest, there is plenty of reason for optimism about world food supplies for next year, and indeed for the next decade.

"The fountains of innovation have not dried up": a new high-lysine corn is nearly ready for release, and today's high food prices and widespread concern about future food supplies will generate more new technology and new resources.

Admittedly, the food situation in some less-developed countries remains "precarious." But "the average person in an underdeveloped country is better fed today than was his father," says Dr. Paarlberg, and we are at the end of a 25-year period of "perceptible improvement in per capita world food supplies." Taken as a whole, Dr. Paarlberg told an M.I.T. seminar this summer, "ours is the first generation in the history of the world that can foresee food enough for all, . . . that can think of moving out of the 'Malthusian cycle'."

—From Nevin S. Scrimshaw, Head of the Department of Nutrition and Food Science at M.I.T.: such an aggregated view hides some significant problems and neglects some potentially serious constraints. Despite the worldwide prospect, food production per capita has declined in the last quarter century in some underdeveloped countries, and there are in fact larger absolute numbers of malnourished people in the world today than ever before.

We tend to neglect the potential effects of three serious constraints on agriculture: the growing price and declining supply of fertilizer (the spring wheat crop in India was down 2 million tons because of this factor alone), a possible shortage of water (due in part to shortages of fuel for pumping it), and shortages of land for agriculture.

What about the effect of climate? Growing conditions in the world's main farm belts have been extraordinarily good in the last quarter-century—substantially better than in the average of recorded history for those areas. Poor weather in North America and Australia—much of the world depends on imports from those areas—could be disastrous, thinks Dr. Scrimshaw.

Are these views in fact divergent and contrary? Perhaps not.

Dr. Paarlberg admitted that world food supply and demand is an "enormously complex" subject, and one can find "ample basis for optimism or pessimism" in any set of statistics on it. If, for example, U.S. consumers reduce their use of beef, will the grain they save go onto the world market—or will farmers simply reduce their acreages in wheat?

Both analyses reveal the world's dependence on food grown in North America; indeed, said Professor Eugene B. Skolnikoff, Director of the M.I.T. Center for International Studies, the U.S. is "the Saudi Arabia of food." Any cautious optimism about future food supplies, such as Dr. Paarlberg's, depends on confidence in the mechanisms of the international marketplace to move food from lands of surplus to lands of scarcity. A risky proposition, thinks Dr. Skolnikoff: should a serious food shortage be threatened, will the U.S. respond—as it did last winter during a minor disruption of the soybean market by closing the doors to its larder?

From such speculations comes Professor Skolnikoff's notion that transferring technology may be a better solution than transferring food. But "technology is never a panacea," he warned.—*J.M.*

The Hanky Panky? Henry, or Pete?

Puzzle Corner
by
Allan J. Gottlieb

It is hard for me to believe that this is the start of the ninth year of "Puzzle Corner" in *Technology Review*—plus one year in *Tech Engineering News*, the student engineering magazine. But it is—and so welcome back regular readers, and a welcome to newcomers, too.

For the latter, here are the ground rules: Each month we publish five problems and several "speed problems," selected from those suggested by readers. The first selection each month will be either a bridge or a chess problem. We ask readers to send us their solutions to each problem, and three issues later we select for publication one of the answers—if any—to each problem, and we publish the names of other readers submitting correct answers. Answers received too late or additional comments of special interest are published as space permits under "Better Late Than Never." And I cannot respond to readers' queries except through the column itself.

Here goes.

Problems

O/N 1 This month we begin with a chess problem from Frank Rubin. Black and White are to cooperate to checkmate White in the fewest possible moves, starting from the standard beginning position. What are the moves if Black is constrained to move only one piece with which he may neither capture nor give check (he may, of course, mate with the piece)?

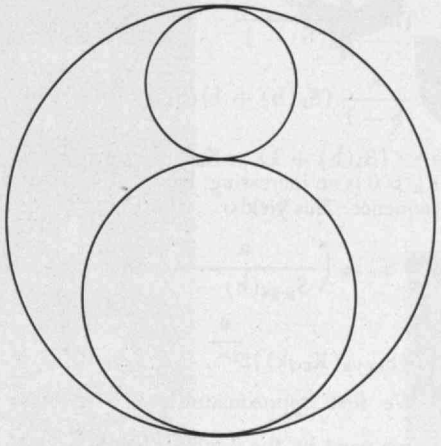
O/N 2 The following problem is from Harry Zaremba: From Pascal's triangle of binomial coefficients arranged in rectangular form, find a formula which yields the value of any element in the array.

n \ m	1	2	3	4	5
1	1	1	1	1	1
2	1	2	3	4	5
3	1	3	6	10	15
4	1	4	10	20	35
5	1	5	15	35	70

In other words, what is $P_{m,n}$?

O/N 3 Lars H. Sjodahl has submitted the following baseball problem: Two players on a baseball team each hit a foul ball in every inning of a nine-inning game in which their team was shut out. If neither was the lead-off hitter, what were their positions in the batting order, and how did this happen?

O/N 4 The following geometry problem was given to me by my York College colleague Gerald Stoodley: Given three circles of radii 1, 2, and 3 as in the diagram, how large a circle can be drawn inside the biggest circle and outside the other two?



O/N 5 An anonymous reader wants a proof that

$$\int_{-\infty}^{\infty} H_{4n+2}(x)\ \mathrm{sech}\left(\frac{1}{2}x\right) e^{-\frac{1}{2}x^2}\ dx = 0$$

where H_m, the mth Hermite polynomial, may be defined by

$$H_m(x) = (-1)^m e^{x^2} d^m/dx^m\ (e^{-x^2}).$$

Speed Department

O/N SD1 Bob Baird wonders in how many trailing zeros does 100! end?

O/N SD2 The following is from Frank Rubin: One pipe fills a tank in a hours, a second fills the same tank in b hours. When working together, they fill the tank in c hours. Find all sets of positive integers a, b, and c satisfying these conditions.

Solutions

The following are solutions to problems published in the May issue.

MAY 1 Given the following hands,

♠ K 3 2
♥ 7 5 2
♦ J 5 3
♣ K Q 7 2

♠ A Q J 10 5
♥ K 6 4
♦ A Q 7
♣ A J

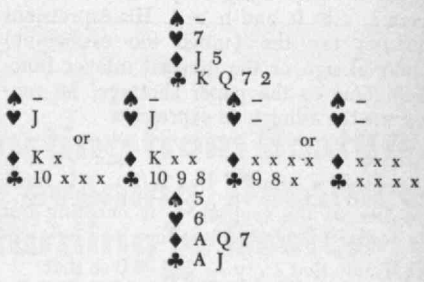
North-South, playing the precision club system, arrive at an optimistic contract of six spades:

N	E	S	W
		1C	1H
DBLE	P	1S	P
2S	P	3H	P
4C	P	4D	P
6S	P	P	P

The opening lead is ♥A, followed by ♥Q. East follows to the second heart as South wins with the ♥K. How can South make the contract?

Everyone agrees that there are possible distributions for which the contract cannot be made. Each person made various assumptions about card placements. In light of the bidding I rejected the possibility that the ♦K is finessible. As I have said, I am not an expert in bridge; but Michael Kay (the proposer) seems to me to have the best solution, especially in light of the "historical" information supplied. His solution is as follows:

West probably has the ♦K for his (light) overcall, so the diamond finesse is not a percentage play. However, if West held five hearts for his overcall (not unreasonable), and if he holds any four clubs or exactly ♣10, ♣9, and ♣8 if he holds only three, the hand can be made. Five rounds of spades are played, leading to this position as the last one is led:



West is squeezed on the ♠5 if he holds four clubs; a heart or

diamond pitch subjects him to a diamond-club or heart-club squeeze. A club discard is played exactly like the ♣10-♣9-♣8 holding: North discards the ♦5. South cashes the ♣A and overtakes the ♦J with the ♦Q. The ♣K clears the suit (or establishes the ♣7), and the lead of the ♣7 squeezes West in the red suits—South holding the ♦A and ♦Q and dummy and the ♥7 and ♦J. West actually held the ♣10, ♣9, and ♣8 when this hand was played in a duplicate tournament. North-South scored a top board for making six spades. (The proposer was South.—Ed.)

Also solved by Ernest Bivans, Winslow Hartford, and R. Robinson Rowe.

MAY 2 Prove that **PERM 1** (Use each of the four digits 1, 9, 7, and 3 exactly once, and using any mathematical symbols, construct expressions yielding as many numbers, beginning with 1, as possible.) can be solved for all integers; or, letting n be any integer greater than 2, prove that the set of numbers

$$\sqrt{\sqrt{\cdots\sqrt{n!!\cdots!}}}$$

is dense on the interval $[1, \infty)$.

There is a great deal to report on this one. First of all, I received the following letter from Juan Maran which proves that it is possible to construct all numbers in **PERM 1** if one uses greatest integer; thus I will cease to publish such numbers unless a flaw is found in solution c below. Juan Maran writes:

My family has come up with the following solutions:

a. My wife Juanita has decided that the solution

1, 9−7, 3, . . .

is elegant, terse, and ideal since it exhibits all the solutions simultaneously.

b. My own answer uses only the universally recognized Maran-Peano successor function (or the interrogative factorial as many of you know it): x? which is defined as the least integer greater than x. Then:

$1 = 1 \cdot (3 + 7 - 9)$

$2 = 1? \cdot (3 + 7 - 9)$

$3 = 1?? \cdot (3 + 7 - 9)$ etc.

These expressions have the advantage of needing but the number one to generate any other, and it is certainly "algorithmic." The only disadvantage I can see is that expressions of large integers tend to be overly inquisitive.

c. My son Juan Jr. claims that he can approximate *any number* greater than (or equal to) one using only the three numbers 1, a ≥ 0, and b > 1. His expressions do not use the (much too exuberant) factorial sign or the greatest integer function. Due to the paper shortage, he represents the admissible expression

$\sqrt{\sqrt{x}}$

(iterated n times) by $S_n(x)$. (I think the use of the symbol $\sqrt{}$ is cheating but he insists I include his effort.)

First note that $(\sqrt{y} - 1)^2 \geq 0$ so that

$$\frac{1}{2}(y - 1) \geq \sqrt{y} - 1, \text{ and}$$

$$\frac{1}{2}(\sqrt{y} + 1) - 1$$

$$= \frac{1}{2}(\sqrt{y} - 1) \leq \frac{1}{4}(y - 1)$$

$$= \frac{1}{2}\left(\frac{1}{2}(y + 1) - 1\right).$$

Iterating, $\frac{1}{2}(S_n(b) + 1)$

$$- 1 \leq 2^{-n}\left(\frac{1}{2}(b + 1) - 1\right).$$

A positive term series Σa_n converges if and only if the infinite product $\Pi(1 + a_n)$ converges. Applying this theorem with

$$b > 1 \text{ to } a_n = \frac{1}{2}(S_n(b) + 1) - 1,$$

we see that $\prod_{n=1}^{\infty} \frac{1}{2}(S_n(b) + 1)$

converges since the series

$\Sigma\left(\frac{1}{2}(S_n(b) + 1) - 1\right)$ is bounded

above by the series

$$\left(\frac{1}{2}(b + 1) - 1\right)\Sigma 2^{-n} = \frac{1}{2}(b - 1).$$

Thus, $\frac{a}{S_n(b) - 1}$

$$= \frac{a}{b - 1}(S_n(b) + 1)(S_{n-1}(b) + 1)$$

$\cdots (S_1(b) + 1) = K_n 2^n$ where $K_n > 0$ is an increasing, bounded sequence. This yields:

$$(*)\ S_{m+k}\left(\frac{a}{S_{n\cdot 2^k}(b) - 1}\right)$$

$$= (S_{m+k}(K_{n\cdot 2^k}))^{\frac{n}{2^m}}.$$

We first approximate $\log_2 c$ as close as we want by the 2-adic fraction $\frac{n}{2^m}$, and then we let k be appropriately large so that $S_k(S_m(K_{n\cdot 2^k}))$ is sufficiently close to one. For these choices,

$(*) \sim 1 \cdot 2^{\log 2^c} = c$.

For **MAY 2**, an exact expression for an arbitrary positive integer n is called for, so that one application of greatest integer brackets is needed. Let a = 97, b = 3, and $c = n + \frac{1}{2}$ in (*) above. Then

$n = [(*)]$.

Several readers have noticed that if logs are allowed instead of greatest integer, all integers may be generated fairly easily. The following from Jack C. Fiore is a good example: In order to generate the positive integer n (or zero), use

$$\frac{\log\left(\log \sqrt{\sqrt{\sqrt{3}}}/(\log\sqrt{9})\right)}{-\log(7 + 1)}$$

For −n, omit the minus sign in the denominator.

Finally, Frank Rubin has a sketch of how one might prove that

$$\sqrt{\cdots\sqrt{n!!\cdots!}}$$

is dense. He wisely denotes the expression with p factorials and q square roots by E(n,p,q) and proceeds as follows: For p greater than 0 we note that E(n,p,0) is the factorial of a large number, M, and express it as 2^{2^x} (x real). Now E(n,p,q) $= 2^{2^{(x-q)}}$. So for every integer i not greater than x and fixed n and p there is a member of the sequence for which

$2^{2^{i-1}} \leq E(n,p,q) \leq 2^{2^i}$

Now M! is a product of several prime integers. Therefore, $\log_2$ M! is the sum of $\log_2 p_i$ for p_i prime and not all $p_i = 2$. For $p_i \neq 2$, each such $\log_2 p_i$ is a transcendental number and the fractional part of the sum of several of these terms is essentially random. In particular the sum lies at a random position between 2^r and 2^{r+1}. Thus $x = \log_2 \log_2$ M! consists of an integer plus a random fraction.

Since M!! and M!!!, etc., involve new primes not in M!, their fractional portions will be independent. Thus for fixed i there are $q_1, q_2, \ldots$ such that $E(n,1,q_1)$, $E(n,2,q_2)$, . . . lie in the interval $I_i = 2^{2^{i-1}}, 2^{2^i}$ at independent random positions. Thus the sequence is dense in I_i for all i. Since the union of the I_i's gives all positive reals, the sequence is dense everywhere.

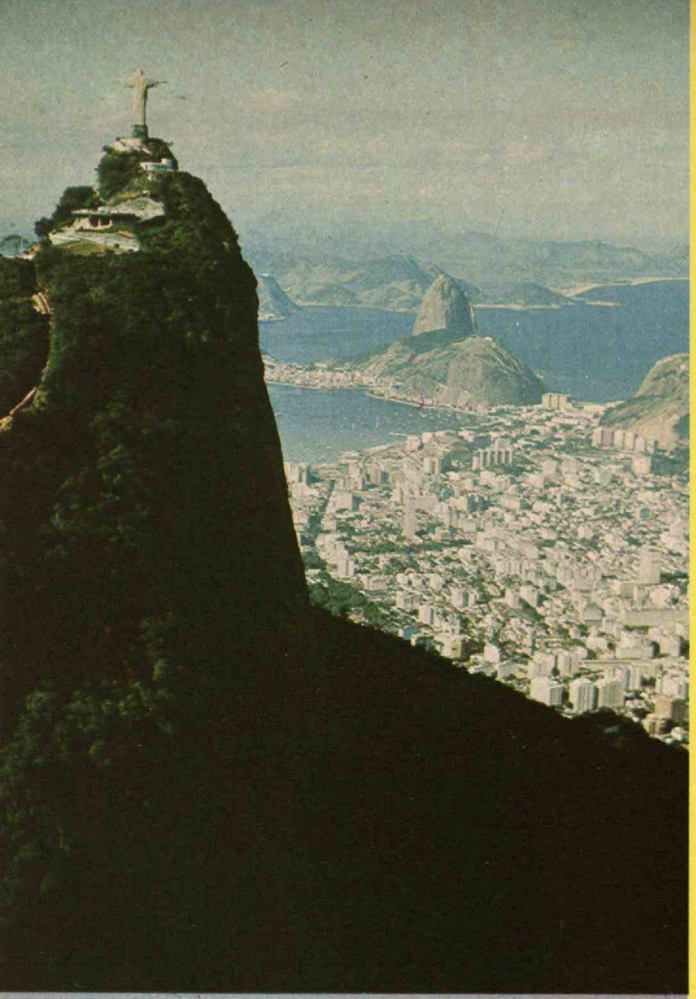
Responses were also received from Emmet Duffy and Ralph Beaman (see also **PERM 1**, below).

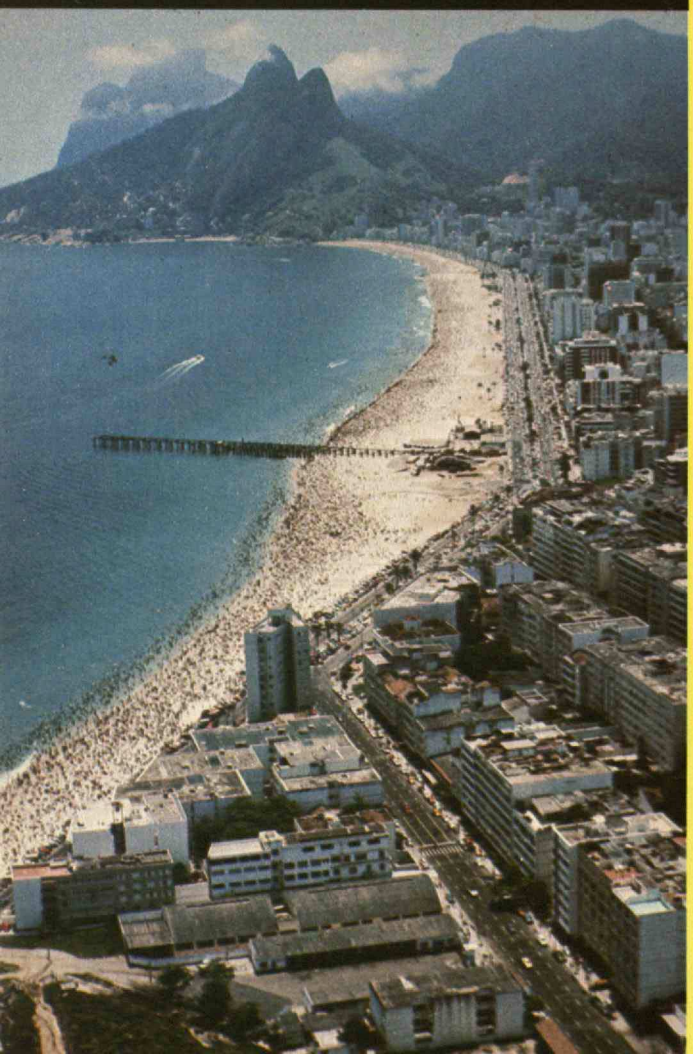
MAY 3 Can any square matrix composed only of zeros and ones of size n by n have determinant no greater than F_n (F for Fibbonacci), where F_n is defined by $F_1 = F_2 = 1$ and for n at least three $F_n = F_{n-1} + F_{n-2}$?

John Prussing and R. Robinson Rowe have algorithms for generating n by n matrices with determinant F_n. But neither has presented a rigorous proof that the matrix so generated has maximal determinant, so the problem is still officially open.

MAY 4 How many different possible bridge auctions (legal sequences of bids) exist?

Amazingly enough the three people who computed the answer obtained the same result. I had expected this to be another case of "majority rules." The following is from Eric Jamin: Call a "true bid" any bid which is not pass (P), double (D), or redouble (RD). Any auction except PPPP includes j true bids, j varying from 1 to 35; 35 is the total number of true bids from one club to seven no-trump. For a given j there are C^j_{35} possible sequences of true bids. Inclusion of P, D, and R gives four possible sequences before the first true bid (—, P, PP, PPP), seven possible sequences after the last true bid (PPP, DPPP, PPDPPP, DRPPP, DPPRPPP, PPDRPPP, PPDPPRPPP), and 21 possible sequences between two consecutive true bids (the above seven with PPP changed to either —, P, or PP). Thus for a given j we have $4 \times 7 \times 21^{j-1} \times C^j_{35}$ possible auctions. Summing over j and adding 1 for PPPP gives A =





M.I.T. QUARTER CENTURY CLUB

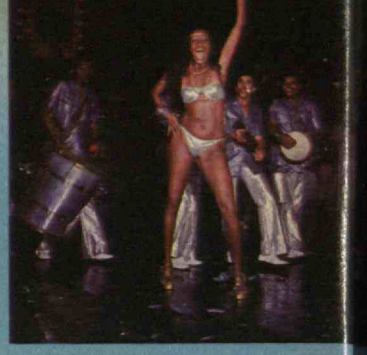
RIO

$349**

plus 10% Tax and Service

Departing from Boston
Tuesday evening, December 3
Returning to Boston
Wednesday, December 11



*For less than half the normal airfare alone, we're going for a week-long vacation to the fun capital of an entire continent and "the most beautiful city in the entire world" (Richard Halliburton, Book of Marvels). This is the famous, pearl-white city etched by soaring mountains and jungle forests against the blue of the South Atlantic, with a year-round perfect climate * and a year-round carnival spirit, the world's most exquisite beaches, a treasure trove of precious gems, and unlimited, all-night entertainment. Here are gorgeous girls from Ipanema, minstrels singing in the street, colorful dancers of Samba and Bossa Nova, and voodoo witchdoctors in outlying favelas. We can idle here in open-air cafes, stroll the serpentine mosaic walks, enjoy the world's best steak and coffee, dance 'til dawn in a two-thousand seat nightclub, or browse in an endless array of boutiques. Onetime capital of a Portuguese Empire, with architecture and culture of a colonial past, it is now the spiritual capital of a progressive nation whose independence, like our own, was inspired by Thomas Jefferson.*

During our winter, the weather in Rio is like our summer, and during our summer, the weather in Rio is dry and in the 70's.

Our trip is planned to include:

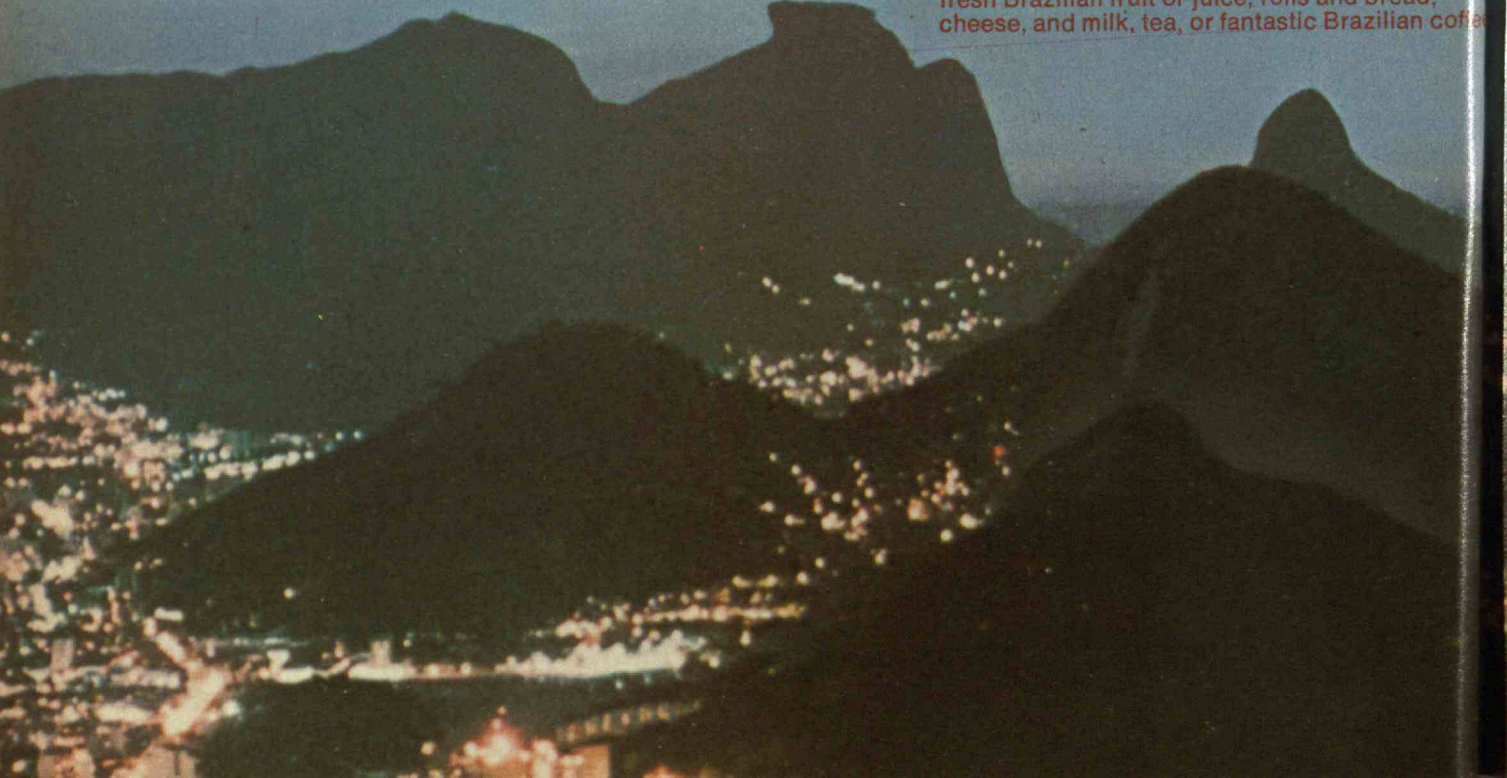
* Round-trip Jet Flights between the city of departure in the United States and Rio de Janeiro, Brazil, via a large, four-engine DC-8 jet of America's Trans International Airlines, the world's most experienced charter airline, with full-course meals and complimentary beverage served aloft.

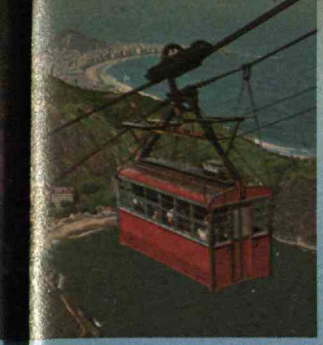
* On arrival in and departure from Rio, round-trip motorcoach transportation for passengers and luggage between Rio's Galeao International Airport and the hotel, including porterage of luggage into and out of hotel rooms.

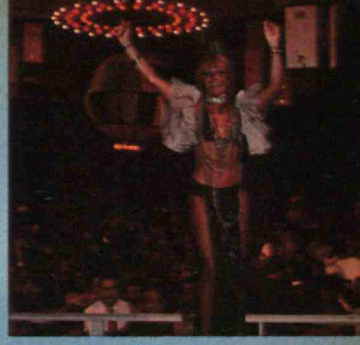
* First-Class Hotel Accommodations for seven nights at the Guanabara Palace Hotel, one of Rio's largest (22 floors with 306 rooms) hotels. Our rooms all have double or twin beds, air conditioning, telephone, radio, and private bathroom with bath, and shower; they are large, clean and appointed with traditional Brazilian furnishings. The Guanabara Palace Hotel is centrally located, facing Rio's beautiful Candelaria Church (pictured above), and is but a ten minute ($1.00) taxi ride from Rio's famous beaches (a city bus [$.10 per passenger] leaves every few minutes from the hotel's entrance). The Guanabara Palace's facilities include an international restaurant, bar, recreation lounge, barber shop, and 24-hour room service.

* A Samba Welcome Party for the entire group, featuring live performers in native Brazilian costume, a chance to imbibe the musical spirit.

* A Brazilian Breakfast each morning, consisting of fresh Brazilian fruit or juice, rolls and bread, cheese, and milk, tea, or fantastic Brazilian coffee.





Two Half-Day Motorcoach Sightseeing Tours (one in the morning and one in the afternoon), with expert English-speaking guide, will show us Rio's important places such as: *Sugarloaf Mountain and Corcovado (2,400 feet, surmounted by 120-foot Statue of Christ); the Guanabara Palace (now the Governor's home); Copacabana, Ipanema, Flamengo and Leblon beaches; Praca da Gloria (residence of the Archbishop); the beautiful Quinta da Boa Vista Park (formerly the Emperor's private park) with Rio's Aquarium and its Zoological Gardens (world's largest collection of tropical birds); The Botanical Gardens (7,000 flower species) approached by the exquisite Avenue of Royal Palms; Flamengo Park (largest city park in South America); the Cinelandia Entertainment Quarter (Rio's Times Square with a score of theatres); the Opera House, Comic Theatre and Municipal Theatre; Tijuca Forest (fantastic jungle rain forest where monkeys play) with the Paul and Virginia Grotto and the Mayrink Veiga Chapel (paintings by Portinari); Dogface Hill with imposing Fort Sao Joao; the Museum of Modern Art (fabulous Picassos, Braques and Matisses); the National Museum of Fine Arts; the fascinating Museum of the Indian; the Geographic Museum (showing Brazilian artifacts and products); Itamaraty Palace (containing antiques, tapestries and objets d'art); Maracana Stadium (world's largest capacity: 200,000); the 18th Century Church of Nossa Senhora da Gloria (with its Bible scenes in blue tile); the lovely double-turretted Portuguese Church of Santa Luzia; the exquisite Church of Sao Bento; the Botafogo quarter with its interesting Synagogue; beautiful Guanabara Bay; Arched Viaducts (on the Roman model); Avenida Presidente Vargas (Rio's Champs-Elysees); the elite Jockey and Yacht Clubs; the Reboucas Tunnel (South America's longest); Praca Paris (with its French gardens); and much more.*

* A Two-Hour Cruise in Guanabara Bay will take us by ferryboat from 15 November Square round trip to exquisite Paqueta Island (called "Lovers' Island"), the most beautiful of the Bay's 150 islands, with its lovely beaches and fanciful horse-drawn carriages.

* A Brazilian Beef Dinner, one evening, at one of Rio's Churrascarias (native translation of the American steak house), our chance to sample world-famous Brazilian meat in a delicious meal, including after-dinner Brazilian coffee.

* A Visit to a Gem-Cutting Workshop, one morning, will show us the processes which make Brazil the jewelry treasure chest of the world. During the visit, we shall receive a complimentary collection of gem-stones in their natural state.

* Special Shopping Discounts have been arranged for us, particularly at Mesbla S/A, Rio's most prestigious department store. A chance to save money on our purchases of famous Brazilian leatherware, woodcarvings, and fashion.

* A Map of Rio and a Guide to Rio will be provided to each passenger upon arrival at the hotel, helpful information to facilitate our plans.

* The Services of International Weekends, Inc. Tour Host Personnel will be available to our group throughout the trip, well-informed people to advise and assist us as we may require.

* "Tax and Service" is included in the trip, meaning all taxes, tipping, and service charges in connection with the land arrangements in Rio de Janeiro, including all tipping for bus drivers, bellmen, maids, waiters, maitres d'hotel, and tour guides.

round-trip jet transportation (on charter flights) between the city of departure in the United States and Rio de Janeiro, Brazil, transfers of persons and luggage, on arrival and departure, between Rio's airport and the hotel, hotel accommodations, on a double occupancy basis, for seven nights in the Guanabara Palace Hotel or equivalent, two motorcoach sightseeing tours of Rio, a continental breakfast each morning, a welcome get-together for the group, round-trip passage by ferryboat to Paqueta Island, one dinner, admission to a gem-cutting workshop, shopping discounts, the services to the group of tour host personnel, and Tax and Service. The phrase "Tax and Service", as used in this folder, means and includes only the taxes, tipping and service charges with respect to the included land arrangements in Rio. The constitution of the total price for this trip (air transportation, land arrangements, and administration) and possible price fluctuations therefor are set forth elsewhere on the back cover of this folder. The items enumerated in the first sentence of this paragraph are expressed in general terms, because International Weekends, Inc., (the "Travel Agent") reserves the right, without having to refund any monies to the passengers, to alter, change, or make substitutions in the trip, its itinerary, and its features provided that such alterations, changes or substitutions do not diminish the aggregate fair market value of what is to be included in the trip. The price of this trip does not include expenses of passports, items of a personal nature such as laundry, telephone, food and beverage other than specifically included, United States and Brazilian Airport Departure Taxes, currently $3.00 and $3.60 respectively (for which taxes each passenger should be invoiced before departure), or any other item not specifically stated herein to be included in the price of the trip.

SINGLE RESERVATIONS: The price stated on the front cover of the brochure is per person based on double occupancy of a hotel room. Single reservations require an additional charge of $69.

DOCUMENTS: Each passenger is responsible for obtaining and having with him a valid passport and a certificate of smallpox vaccination issued within three (3) years preceding departure.

Passengers born in communist countries, and passengers carrying passports from communist countries are responsible for checking visa requirements with the Brazilian authorities no less than two months before departure.

LUGGAGE:
Each passenger on board the aircraft is limited to 44 lbs. of baggage, subject to the further limitation that he have no more than one suitcase and one small carry-on piece. Throughout the trip, luggage travels strictly at the risk of the passenger, and the Travel Agent shall not be responsible or liable for any delay in the transportation of, for any loss of, or for any damage to passengers' baggage (or its contents). Baggage insurance is available and recommended.

FINAL PAYMENT AND CANCELLATION:
Payment of final balance is due sixty (60) days in advance of departure (at which time reservations will be confirmed). Reservations may only be cancelled by written notice sent by registered mail (return-receipt requested) to the Travel Agent. If such notice is received by the Travel Agent no later than sixty (60) days before departure, the Travel Agent will accept the cancellation and Agent will accept such cancellation and refund monies only if the cancelling party finds eligible substitute(s) for the reservation(s) being cancelled. Cancellation insurance (protecting against the loss of air fare) is available and recommended.

ELIGIBILITY:
Participation in this trip is limited to those persons who, for six months preceding departure, have been members of the organization whose name appears on the front cover of this folder, such

Optional Side Trips

Here are a few of the optional side trips available for purchase.

AN EVENING OF VOODOO
A spellbinding evening of the witchcraft Macumba ritual.

JUNGLE SAFARI
A penetrating tour of where the monkeys play.

VISIT TO AN EMPEROR'S CITADEL
A full-day trip to the heights of Petropolis with its beautiful hilltop edifices.

AFTERNOON OF HORSE RACING, SOCCER, OR GOLF
Special arrangements are available for the lovers of the game.

DAY IN SAO PAULO OR BRAZILIA
Fly to these exciting cities for a day of sightseeing with return flight the same evening.

AFTERNOON AT A "DISNEYLAND"
Lovers of amusement parks will enjoy this afternoon visit to one.

NIGHTS ON THE TOWN
A variety of nightclub tours to the best of Rio.

INSURANCE:
Ordinary travel insurance is available for those who wish it.

RESPONSIBILITY, ETC.: Each person making reservations for or participating in the trip described in this folder understands and agrees to all the terms, conditions, and limitations set forth in this folder including the following: The air transportation for this trip is held out and engaged by the sponsoring organization whose name appears on the front cover of this folder, which organization acts only as agent for the group of persons being transported thereby. In endeavoring to make arrangements with various persons, firms, and corporations for the services and accommodations described in this folder to be included in this trip, International Weekends, Inc. (the "Travel Agent") acts only as agent for the participants in the trip, and, as such, the Travel Agent shall not be responsible or liable for, and expressly disclaims any responsibility or liability for, any loss, cost, injury, expense, or damage to person or property which results, directly or indirectly, from any act, whether negligent or otherwise, of commission or omission (including but not limited to delays), of any person, firm, or corporation which is to, shall, or does provide products or services in connection with the trip, including but not limited to transportation services (whether by air, sea, or land), lodging, food and beverage, entertainment, sightseeing, luggage handling or tour guiding or escorting. The Travel Agent reserves the right to decline, accept, or retain, at any time and for any reason, any person as a participant in the trip. If any person is removed by the Travel Agent from the trip, a proportionate refund for unused services will be made. The Travel Agent reserves the right to cancel the entire trip for any reason and at any time before departure, in which event the liability, if any, of the Travel Agent shall be limited to refunding to each prospective participant the monies paid to the Travel Agent by such person for the trip, which monies have not been or should not be otherwise refunded to him.

**The price of this trip is constituted as follows: Air transportation, $232.67 per person; land arrangements, $148.23 per person; administration, $3.00 per person; total price, $383.90 per person.

The air fare stated above is a pro rata cost to each of 254 passengers; should there be fewer than 254 passengers, each passenger may, at least forty-five days before the departure date, be notified of any increased pro rata cost to him and will have the option to pay the difference or cancel without penalty. The cost of the trip is based on the monetary exchange rate of U.S. Dollars to Brazilian Cruzeiros as existed on January 1, 1974 and on tariffs, rates and costs in effect as of January 1, 1974; should there be, between then and the date of departure, an increase in such exchange rate or in such tariffs, rates or costs, each passenger may be required to pay an increased amount for the trip reflecting such increase.

The aircraft being utilized for the transatlantic air transportation is a DC-8 jet with seating for 254 passengers. Reservations applications will be processed strictly in order of their receipt by the Travel Agent, with a waiting-list maintained for any reservations in excess of 254. All reservations applications must be mailed, in all events, before the reservations deadline set forth below.

FINAL RESERVATIONS DEADLINE

MAIL IMMEDIATELY

THIS WAY TO RIO

TO:
Mr. Jack Newcomb
M.I.T. E-19 238
77 Massachusetts Avenue
Cambridge, MA 02139

MY CHECK IS MADE PAYABLE TO:
M.I.T. Quarter Century Club

Enclosed is $_____($100.00 per person) as deposit for_____ reservation(s) on the Rio Trip subject to the terms stated in this folder.

NAME(last) _____ (first) _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

TELEPHONE(9-5) AREA CODE_____NUMBER_____ (after 5) AREA CODE_____NUMBER_____

☐ I REQUEST A SINGLE ROOM ☐ I REQUEST A DOUBLE ROOM TO BE SHARED WITH

_____
(Name & Address)

I have attached a list of names, addresses, and telephone numbers of those persons for whom I am requesting reservations, and have indicated whether single or double accommodations are required.

RIO1204A-MIT

INTERNATIONAL WEEKENDS, INC.

The Group Travel Specialists
120 Water Street
Boston, Massachusetts 02109
Telephone 617/723-8300
TELEX 94-0847 INTL WKNDS

Printed in U.S.A.

$4(22^{35} - 1)/3 + 1$, or A = 1287456503470306831202319261116093713631226975 57.

Frank Rubin and the proposer, Neil Cohen, also obtained this result, and estimates were received from Emmet Duffy, Winslow Hartford, and R. Robinson Rowe. The latter owes me 25 cents since he bet two bits that "Neil Cohen doesn't know the answer to his own problem."

MAY 5. There was this picnic attended by Belinda the wife, Henry her husband, Joe their son, Mimi their daughter, and Pete, Belinda's brother. At some time during the picnic one of the members poured a can of beer over the head of another member. At that time:

1. A man and a woman were at the table.
2. The victim and the guilty one were at the beach.
3. One of the children was in swimming.
4. Belinda and her husband were not together.
5. The victim's twin was not the guilty one.
6. The guilty one was younger than his victim.

Who done it?

Henry gave it to Pete, as the following solution from Alan Faller (he says the problem is "easily solved") illustrates:

Denoting the cast by their initials H, B, J, M, and P, after simply applying clues (1), (3), and (4) and noting that P could be a child, the following six possibilities remain:

	At table	At beach	Swimming	Result
(a)	H, M	B, P	J	x
(b)	H, M	B, J	P	x
(c)	J, B	H, P	M	yes
(d)	J, B	H, M	P	x
(e)	P, B	H, M	J	x
(f)	P, B	H, J	M	x

Clue (6) rules out (d) and (e). Now we must assume that clue (5) solves the problem and that the victim's twin is one of the other characters. The victim must be B, J, M, or B. Case (a) is ruled out by clue (5). If (b) were true then by clue (6) J would be guilty, but then P (cousin of B) would not be a child. Cross that out. Case (f) is ruled out because J is the younger and H has no twin in the scenario. The answer, therefore, is case (c), and Henry (the cad) dumped the beer on his older brother-in law Pete, his wife's twin. The real problem is: Why did he do it? Perhaps your readers could provide some interesting answers to that. My guess is that he was making advances toward Mimi, who was in the water alone while the rest of the family was at the picnic table and that Henry arrived just in time. So Henry wasn't the cad after all. It was Pete!

Also solved by Ernst Bivans, Richard Chapman, Joseph Haubrich, Josh Jaffee, Eric Jamin, Harold Groot, Neil Hopkins, Mary Lindenberg, George and Margaret Marcov, Theodore Mita, Russell Nahigian, Edward Moore, John Prussing, R. Robinson Rowe, Frank Rubin, Don Tymchuck, Avi Ornstein, and the proposer, Jim Cassidy.

Better Late Than Never

PERM 1 As mentioned above (see **MAY 2**), we now have a proof that all numbers are possible if one uses the greatest integer function. Thus I will no longer print solutions using this function. I must, however, mention an astounding effort submitted by Edward and William Wong: they gave solutions for each number from 408 through 1,834; I am truly impressed. The proof of **MAY 2** is fortunate indeed; otherwise my editor would have faced the prospect of printing over 1,400 solutions. I am saving the Wongs' work in case a flaw is found in **MAY 2.**

Meanwhile, the only interest left in **PERM 1** is in solutions not using the greatest integer. Through the July/August issue, we published answers up to 256 with 22 exceptions. Below are listed last year's gaps and improvements submitted this summer:

135	187 = 7 + (3!!/(1 + $\sqrt{9}$))
149	202
152	205
155	206
163	212
166	227
172	229
178	230
	235
181 = 1 + (3!!/(7 − $\sqrt{9}$))	245 = 7(3!$\sqrt{9!}$ − 1)
184	254

A few solutions beyond 256 are here and will be published in the December *Review*; meanwhile, let's fill in the gaps above. These results were taken from letters from Eric Jamin, Andrew Seager, Harold Groot, E. W. Kelley, Greg Girolami, Alfred A. Aburte, Jr., M. Kaufman, Jim Marlin, David Mallenbaum, Emmet Duffy, and Stuart D. Casper.

Several suggestions for possible **PERM 2**'s are in hand, one of which may soon be adopted.

FEB 4 Joseph Haubrich writes that Mary Youngquist's solution seems to have left out err, "which would give her a ten-fold homonym, beating out what the *Guinness Book of World Records* gives as the greatest, roz, which is everything from the flower to the plural of the Greek letter."

J/A SD1 John E. Gerli disagrees with the solution as given. He feels that the cream should be added early so that it will float to the top and act as an insulator.

Harold Groot has responded to **JAN 1**, George Uman to **JAN 3**, and Eric Jamin to **FEB 1**, **M/A 1**, **M/A 3**, **M/A 4**, and **M/A 5.**

Proposer's solution to **O/N SD2**, above: Let m and n be arbitrary integers; then $a = m(n + 1)$, $b = mn(n + 1)$, and $c = mn$.

Allan J. Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now a member of the mathematics faculty at York College of C.U.N.Y. Send problems, solutions, and comments to him at the Department of Mathematics, York College, 150-14 Jamaica Ave., Jamaica, N.Y. 11432.

Books

How It Was On the Way to the Moon

Carrying the Fire:
An Astronaut's Journeys
Michael Collins
New York: Farrar Straus and Giroux, 1974; 478 pp., $10.

Reviewed by James E. Oberg

What was it really like "out there" in space?

We watched it on television, saw the photographs in the newspapers, and read the astronauts' own stories in the magazines.

But what was it really like?

Michael Collins, veteran of two flights into space, tells in this semi-autobiographical account—no ghost writer here, in contrast to the many space memoirs now appearing—what it was really like to be an astronaut in the 1960s. The style is alternately witty, lucid, irreverent, and serious; the result is a fascinating book. "I bore easily," Collins observes early in the book, "and I have written this book for people who bore easily."

The story of Collins' career as an astronaut is woven through the whole U.S. manned space program. Picked for the third class of astronauts in 1963, Collins underwent the standard training program from centrifuges and classroom study to jungle survival. He was the Project Officer for the design and development of the Gemini and Apollo spacesuits. The first of his class of 14 to be assigned to an actual space crew, he trained as Jim Lovell's backup on Gemini-7 in 1965, and he was co-pilot on the 3-day Gemini-10 flight the following year.

Beyond chronology, the book vividly portrays the flavor of astronaut duty during the "moon race." There were real problems and real solutions in the Apollo program. Collins wound up breaking the news to a new Apollo widow in 1967, and he eloquently describes his own feelings and conclusions about the deaths of several of his closest friends in training accidents.

In 1967 Collins was assigned to Apollo-8, which on Christmas Eve 1968 became the first manned spaceship to circle the moon. Collins, however, was not on board; he had been grounded a few months before for spinal surgery, and his backup man, Jim Lovell, took his place. But this accident led to his assignment to Apollo-11, which ultimately carried out man's first landing on another world.

Among the explanations, "war stories," and anecdotes are some interesting revelations. Collins, for example, was confident that Apollo-11 was as well prepared as possible, but he still had his doubts about a successful mission. "I think we will escape with our skins," he remembers feeling right before launch, "but I wouldn't give better than even odds on a successful landing and return." As the time came for the "Eagle," down on the moon, to blast off and rejoin Collins, who was circling the moon in the mother ship "Columbia," Collins relates that "I have never sweated out any flight like I am sweating out the LM now. My secret terror for the last six months has been leaving them on the moon and returning to earth alone. . . . If they fail to rise from the surface, or crash back into it, I am not going to commit suicide; I am coming home, forthwith, but I will be a marked man for life and I know it. . . . One little hiccup and they are dead men. . . ."

Collins reveals that there had been a conflict between Armstrong and Aldrin about who would first step out onto the moon. The co-pilot had been tentatively scheduled to go first, but a few months before the flight Armstrong "exercised his commander's prerogative to crawl out first. . . . Buzz's attitude took a noticeable turn in the direction of gloom and introspection shortly thereafter." Collins concluded that "Buzz resents not being first on the moon more than he appreciates being second."

Was there really a "moon race" with the Russians? Critics of the Apollo program claim that the U.S.S.R. never intended to send men to the moon, that the United States' effort was a $20-billion exercise in futility. Collins knows better; he relates a private conversation with cosmonaut Pavel Belyayev in Paris in 1968 when "Belyayev himself expected to make a circumlunar flight in the not-too-distant future." As the launching of Apollo-8 neared later in the year, Collins observed that "the moon beckoned to the Russians as well as to us, and there was a lot of speculation concerning who would fly men around the moon first. A review of the two programs up to the fall of 1968 shows some remarkable similarities." But the Americans won the race; the Russians, rather than face the humiliation of coming in second, cancelled their program and claimed they never had been in the race. Poor Belyayev died of complications during surgery for a severe bleeding ulcer a few months later.

Passages to illustrate Collins' evocative and entertaining style are hard to present out of context. "Gripping" is a word that describes both the flow of the narrative and the recommended policy for holding on to your own copy of the book.

Don't ever ask Collins to autograph your copy, by the way. There is "a special place in hell reserved for autograph seekers," he believes, describing some of the drawbacks to the fame and notoriety involved with being on Apollo-11. But those are a minor issue compared to the "deep sense of satisfaction I feel," for Collins looks back on his role in Apollo "with a mixture of pride, incredulity, and smugness." This was the way it was on the way to the moon.

James E. Oberg is an Air Force Captain assigned to the Department of Defense Computer Institute.

The New Profession of Sports Engineer

Mechanics and Sport
Edited by Jeffrey L. Bluestein
New York: The American Society of Mechanical Engineers, 1973, v + 315 pp., $13.00

Reviewed by William C. Purdy

How can engineering contribute to sport?

Enormously.

In the twenty papers which this book contains (originally given as symposium contributions at the 1973 Winter Meeting of the American Society of Mechanical Engineers) are examples related to fifteen different sports. Alpine skiing (five papers) is apparently most popular, but engineers also brought their talents to archery, baseball, cricket, cycling, football, gymnastics, ice hockey, javelin, long jump, pole vault, rowing, running, sailing, and tennis.

Four main areas of emphasis can be identified: sports-related injuries, human performance, sports equipment, and—combining all of these—sports systems. Sports-related injury deals with passive mechanical properties of the body, forces to which the body is exposed, and protective equipment. Appropriately, the sports considered are alpine skiing and ice hockey. Interest centers on the protection of skiers' legs and hockey players' heads.

The papers concerned with human performance examine movement patterns in kicking, running, jumping, javelin throwing, pole vaulting, and gymnastic. The authors used sophisticated techniques such as computer-aided cinematographic analysis and computer simulation of mechanical linkage models to discover how humans make the appropriate movements with greatest efficiency. "Computerized Biomechanical Analysis of Human Performance" by G. Ariel, which describes the first of these techniques, is especially recommended.

Analysis of sports equipment ranges from the aerodynamics of the cricket ball to a comparison of hydrofoil and catamaran racing sailboats. There are two particularly good papers on the design and performance of skis.

Most elegant, however, are the papers which consider entire sports systems—equipment, participant(s), and environment. An example is "On the Dynamics of Men and Boats and Oars," in which D. L. Pope combines knowledge of rowing with skillful engineering analysis to develop an analytic model for the racing shell, its oarsmen, oars, rigging, and environment. The model is used to deduce the effects of variables such as the slide, catch and recovery angles, and stroke velocity.

This paper exemplifies the challenge and potential of engineering in sport. It also illustrates the difficulties in modeling complex sports systems. An ever-present danger is that concessions made to mathematical tractability will invalidate the model. For example, Pope assumes that the oar blade experiences no lift forces. This assumption, which has important consequences, is open to question; but testing such assumptions against empirical data is often extremely difficult.

An exciting prospect for alleviating this difficulty is found in "Computer Simulation of Bicycle Dynamics" by R. D. Roland. A system consisting of bicycle, rider, and road forces is modeled by a computer program combining modeling and graphics. The point is that computers favor numerical data, but humans assimilate data in graphic form at much higher rates. Roland achieves an accommodation by transforming numerical data generated by computer modeling into sequences of pictures which are then recorded on photographic film. This process in effect presents empirical data in pictorial form (motion pictures); model testing is greatly facilitated and the diagnosis of model deficiencies improved. This is impressively demonstrated by pictures of an actual bicycle slalom maneuver and its simulation. Corroborating evidence of the promise of this technique has appeared recently in aerodynamics research.

Though the contributors to *Mechanics and Sport* have achieved respectable levels of engineering quality, their work is only a beginning; it will not change the teaching or practice of sport. But do not scoff. At a time when technological miracles and world crises are almost commonplace, the value of sport, like humor, is apt to be overlooked. Yet at such times these peculiarly human pursuits assume their greatest importance. Sport offers a unique combination of physical, mental, and social therapy which provides significant relief from the ennui, alienation, and depersonalization that are endemic in our society.

To tap this potential, sport must be made accessible to all. This is where engineering can help. Accessibility implies safe, affordable, high-quality facilities and equipment. It implies guidance and education to facilitate acquisition of sports skills. Serious participation in sport is in large part a response to the need for individual achievement and self-expression. Satisfaction of this need by improving performance is a necessary motivation for continued participation. Clearly, effective educational methods are extremely important. In sport, as in any field, they must be based on a clear, accurate understanding of the mechanics of performance and supported by evaluation and diagnosis through appropriate measurement.

By aiding in the attainment of these objectives, the engineering profession can make important contributions to the quality of human life. And in so doing, it will enter a challenging and largely unexplored area which offers unlimited professional opportunities.

Mechanics and Sport is significant because it signals recognition of this thesis by a prominent professional society. Indeed, it might well mark the inception of a new engineering specialty, appropriately called "sports engineering."

William C. Purdy is Senior Engineer in the Electronics Laboratory of General Electric Co., Syracuse, N.Y. His major areas of interest are computer simulation, computer linguistics, and artificial intelligence; but the engineering aspects of sports have been an avocation since collegiate days at Purdue (B.S., mathematics, 1953) and Cornell (Ph.D., experimental psychology, 1958).

Spruch

Continued from page 13

The Trouble With France Is the French

While the "style" of science inevitably reflects the style of life in a country, the connection between the two is particularly striking in France. French social life consists almost exclusively of family life.

Informal "at home" entertaining is uncommon in France; the family is an important and largely self-sufficient social unit. This family orientation carries over into science in the isolation of different scientific groups, including those in the same field. There is little of the American communications between scientists and between laboratories, just as there is little of the American dialogue between friends.

While the malady is endemic to most of Europe, in France it assumes the proportions of a disease. The French are more insular than their island neighbors, the British. There was no brain drain from France; Frenchmen simply don't like not speaking French.

Another cause of immobility relates to the mating habits of French scientists. An astonishing number are married to scientists, a fashion possibly inspired by the Curies and furthered by their progeny, the Joliot-Curies (five Nobel Prizes among these four; Marie won two, for physics and for chemistry). This means there are two positions to worry about when a move is contemplated.

The housing shortage is still another reason for immobility. Subletting an apartment can result in its permanent loss, for example.

Centralization of What?

How is it, one might ask, that a centralized system can be so fragmented? The answer is that the structure is centrally directed, but the research itself is not.

For anyone who believes a centralized system will automatically lead to the most efficient utilization of resources, French centralization provides a shock. Excellent modern equipment is frequently idle because the equipment budget and the maintenance budget have no correlation, their funds coming from different sources. I visited some friends in the new Faculty of Sciences Building erected on the site of the old wine district of Paris. The building is called the *Halle aux Vins;* it is modern, spacious, and well equipped. My admiration called forth a torrent of complaints. Apparatus had been bought to furnish the building; but in the few years since then, virtually nothing has been spent for equipment, so many instruments already purchased were ineffective, lacking auxiliary equipment required for proper utilization. Because of the multitude of agencies involved in a single project, estimates are that it takes four years from the time funds are promised to the time they can be spent.

One field in which the French *are* international, *do* go abroad and *do* work in teams is high-energy physics. The nature of the subject demands huge accelerators, which, in turn, demand huge expenditures beyond the means of a single European nation, so there is cooperation. France is a member of C.E.R.N., the European nuclear center based in Geneva.

Conversations with high-energy physicists have an entirely different ring from all the others. There is pride, confidence, top-of-the-ladder talk—and English. French high-energy physicists learn teamwork and scientific intercourse at C.E.R.N. and carry them back to France. In high-energy laboratories there is no lack of foreign visitors or of leaves to go abroad. But, of course, high-energy physics has no practical application anywhere at this time.

Grace Marmor Spruch is Associate Professor of Physics at Rutgers University in Newark, N.J. She has written for Saturday Review, New Scientist, Physics Today, *and other publications. Before taking her present post she was Research Physicist at New York University.*

An Institute Informant

The Editors' digest of recent and current concerns at the Massachusetts Institute of Technology

New Research

Though academics may not like to admit it, the future course of research is set in some measure by the priorities of agencies, foundations, and companies with money. Major grants and projects announced at M.I.T. this summer:

Life Sciences

—An ultra-high-frequency nuclear magnetic resonance spectrometer especially designed to study biological molecules will be built in the Francis Bitter National Magnet Laboratory under a $115,000 National Science Foundation grant. It will utilize a superconducting magnet system to detect frequencies as high as 360 MHz., the resonance of the hydrogen ion (proton), and will make possible analyses for such magnetically weak nuclei as carbon, nitrogen, and phosphorus in proteins and nucleic acids.

—Five grants totalling $218,469 from the American Cancer Society will continue a series of studies in the Department of Biology and Center for Cancer Research on RNA viruses, DNA metabolism, nucleic acid structure and immunoglobulin structure, and gene expression in mammalian cells.

—A new Health Sciences Fund at M.I.T. will support research on hemoglobin behavior and synthesis, brain anatomy, space orientation and equilibration in fish and man, minimum protein requirements, viral biosynthesis, RNA tumor viruses, and angiotensin antagonists.

—A grant of $90,106 from the American Cancer Society will support research in gene mapping in the M.I.T. Center for Cancer Research by Paul A. Sharp, who comes to the Institute this fall as Associate Professor of Biology.

Engineering

—A feasibility study of waste-water purification by high-energy electrons is beginning in the High Voltage Research Laboratory under a $113,700 grant of the National Science Foundation.

This picture symbolizes a half-million-dollar gift from Ford Motor Co. to M.I.T. for the Energy Laboratory. The check is for a first installment of $125,000, and the principals in the picture are (left to right) Albert G. Hill, Vice President —Research at M.I.T., Emmett Horton, Director of Engine Research at Ford, and David C. White, Director of the Energy Laboratory.

—Research and teaching under the Institute's Sea Grant Program will be supported by a $710,000 federal grant in 1974-75. Research goals include a predictive hydrodynamic model of greater Massachusetts Bay, including Cape Cod Bay, effects of off-shore oil platforms, the mechanics of oil-spill transport, marine food resources, underwater welding, reinforced plastics in the marine environment, and aquaculture.

—Two grants—$500,000 each from Exxon Corp. and Ford Motor Co.—will support general activities of the M.I.T. Energy Laboratory; specific projects in advanced automotive power systems (National Science Foundation), oil and gas pipeline transmission systems (Federal Energy Office), energy information systems (Federal Energy Office), and the cooling of underground transmission lines (Consolidated Edison Co. of New York, Inc.) are underway for the sponsors indicated.

International Studies

—Research on early 20th century migrations in India and their effects on ethnicity by Myron Weiner, Professor of Political Science, will be continued under a grant from the American Council of Learned Societies.

—Four aspects of the international nuclear power industry will be studied under a $150,000 grant to the Center for International Studies from the Ford Foundation under its competition on "common problems of advanced industrial societies." The M.I.T. work will cover nuclear power costs, regulation, organization, and likely political implications—including the possible proliferation of nuclear weapons as a result of the international spread of nuclear power. Henry D. Jacoby, Professor of Management; Paul L. Joskow, Assistant Professor of Economics; and Joel Yellin, Associate Professor of Social Science, will direct the work.

Nutrition and Food Science

—A one-year study of the relationship between U.S. food policies and international food needs, to be conducted by M.I.T.'s International Nutrition Planning Program and the Harvard Business School and School of Public Health, is funded by a $50,000 grant of the National Science Foundation.

Housing and Urban Affairs

—New forms of housing mortgage financing which could ease home ownership for American families are the subject of research in the Sloan School of Management under an $84,172 grant of the Department of Housing and Urban Development and the Federal Home Loan Bank Board.

—David L. Birch, Associate Professor of Business Administration at Harvard, has been appointed Senior Research Associate in the M.I.T. Department of Urban Studies and Planning to supervise two studies sponsored by the Department of Housing and Urban Development ($725,000) in the Harvard-M.I.T. Joint Center for Urban Studies:

David L. Birch

the evolution of neighborhoods within metropolitan areas, and the migration of residents within cities and between urban and rural areas.

Humanities

—Machiavellianism and the patterns of political secrecy in Renaissance thought and literature will be the subject of research by Peter S. Donaldson, Assistant Professor of Literature, under a Younger Humanist Fellowship of the National Endowment for the Humanities.

New Grants for Continuing Projects

Six grants announced earlier in the year will support continuing research at M.I.T.: materials science and engineering, $1.7 million (National Science Foundation) to continue interdisciplinary research and teaching . . . "dial-a-ride" demand-responsive transportation control procedures, $150,000 (Department of Transportation . . . undergraduate education in naval architecture and ocean engineering, $72,908 (National Science Foundation) . . . development of a new electron accelerator for skin cancer therapy, $50,000 (Fannie E. Rippel Foundation) . . . an undergraduate summer study project in energy utilization, $15,950 (National Science Foundation) . . . a fellowship in nutrition and lung cancer, $10,000 (Council for Tobacco Research).

More Data, Not More Computer

If it's apocryphal, perhaps its participants will forgive us—the story that Governor Francis W. Sargent of Massachusetts called Professor Henry D. Jacoby in M.I.T.'s Sloan School of Management on one of the cold dark days of last winter.

"I can't figure out what's going on," he said. "How much oil are we really short?" asked Governor Sargent.

Professor Jacoby—who was one of a team of energy advisers trying to help Governor Sargent chart the state's course through the oil shortage—scratched his head and rubbed his chin. "I dunno," he said after a minute or two. "Maybe 15 per cent."

For Professor John J. Donovan, who had just joined the Sloan School faculty after a career in computer science in the M.I.T. Department of Electrical Engineering, it was a prime example of a private theory: our problems today won't be solved by bigger and faster computers; we need, instead, better ways of using the computers we have, and better data to give them.

Hence Professor Donovan's organization of a new Information System Center in the Sloan School, which he announced during a session on "Computing and Mathematics in Society" at the 1974 National Computer Conference in Chicago this spring.

The new Center's first project is an energy information system for New England—a deceptively complex undertaking, says Professor Donovan. The problem is that a free market operates without much information; it takes care of itself, and that is its historic advantage. But when you have to intervene in a free market, as we had to last winter in the case of energy (and may again in a future emergency), you need immense amounts of information which have never before existed—and special abilities to manage and correlate all the data when you have it.

For example, how much oil is there in New England? Some of Professor Donovan's students went to the major New England oil companies; no answer—no one knew. Who else might know? Two students decided to ask mayors and fire chiefs in New Hampshire where and how much gasoline was stored under the stately elms and pastoral greens of their towns. On the basis of their answers, the students discovered 28 per cent more storage capacity than anyone knew existed in New England. Other students sought to investigate a report that significant quantities of oil were entering Massachusetts by truck on the Massachusetts Turnpike. After two days beside a windswept toll booth they returned to Cambridge with the answer: no oil.

Other students addressed the computer research issues of how to build flexible computer information systems, still others how to do supply modeling and forecasting.

Out of such data when finally assembled is to come a computer-based energy information system for New England which Professor Donovan and his colleagues can put on the shelf, ready to use in a future emergency. It will constantly monitor a few key variables having to do with the supply and demand for petroleum, and if it senses danger the program will signal its need to activate itself.—*J.M.*

Management Amid Scarcity: New Shapes for an Old Problem

Inflation . . . energy crisis . . . materials shortages . . . unemployment and recession—a revolutionary era in which managers need new skills and tools to assure the productivity and profitability of their companies?

True indeed, says Blaine J. Yarrington, Executive Vice President of Standard Oil Co. (Indiana). It is "the year of the manager," he told an M.I.T. Sloan School seminar in Chicago last spring. It is the manager's job "to see where the company will be next year," said Mr. Yarrington, and in an era of rapid and fundamental change that's a full-time job and more.

Are today's problems and changes so fundamental?

Consider energy. Summarizing for the first time the conclusions of M.I.T.'s "energy self-sufficiency" study which was the single subject of *Technology Review* for May (*pp. 22-58*), Paul W. MacAvoy, Professor of Management who was one of the principal authors, called it "a gloomy picture: severely limited availability of natural gas by 1980 . . . potential for serious dislocations in the upper midwest."

To increase domestic oil production by 1980 will require "an order-of-magnitude increase in all exploration and development," and that simply cannot be done "at anything like the level of prices proposed by the government's 'Project Independence'," said Professor MacAvoy.

Living with Persistent Inflation

Consider inflation. No news to the 1,200 people gathered for the seminar luncheon when Paul A. Samuelson, Professor of Economics at M.I.T., called the American economy "inflation-prone." He thinks the fear of two-digit inflation is so pervasive "on Main St., Wall St., and Pennsylvania Ave." that it is a significant factor in economic forecasting.

And there is "no way in the foreseeable future (by which he meant the next two to three years) to bring the rate of inflation below 8 per cent or more," said Professor Samuelson. "We simply don't know how to do it."

A disaster for the American economy? Not at all. There have been many economic achievements in inflationary eras, said Professor Samuelson, and he advised managers present to "accept it, like the universe."

A more serious problem, thinks Professor Samuelson, is the "massive change" in the balance of world G.N.P.—1 to 1.5 per cent a year—from the industrialized nations to the O.P.E.C. nations. Such a change will

have the effect of depressing the rate of G.N.P. increase achieved by the U.S. as much as 0.5 per cent a year. "It is a microeconomic event of first importance to the Indian farmer and —in the longer run—to us," said Professor Samuelson—a major gradual but inexorable change in the world balance of economic power.

Controls to Stem Inflation?

Can government impose limits on prices and wages to stem inflation? Professor Samuelson was not optimistic: even if they work well in the short run, he thinks, such controls soon enough "spring leaks and become obnoxious."

D. Quinn Mills, Associate Professor of Industrial Relations at M.I.T., drew no comfort from his experience of two years as Special Assistant to the Director of the Cost of Living Council. He admitted that "there is great confusion and divergence of views" on the true effect of wage and price controls as operated by the Nixon administration; but in the long run he concludes that "government cannot restrain inflation simply by administrative . . . decree."

Having learned that lesson, is it safe to think that the wage and price control experiment is over—for good—in America? Not at all, thinks Professor Mills; "the prospect of rapid inflation makes it unlikely that our government will be able long to stand with its head buried in the sand." And so he offered a series of lessons from recent experience:

—No single guideline is appropriate; flexibility in response to different wage and price conditions is essential.

—Effective wage stabilization is impossible without help from labor—and without a mechanism for settling disputes which is respected by both labor and management.

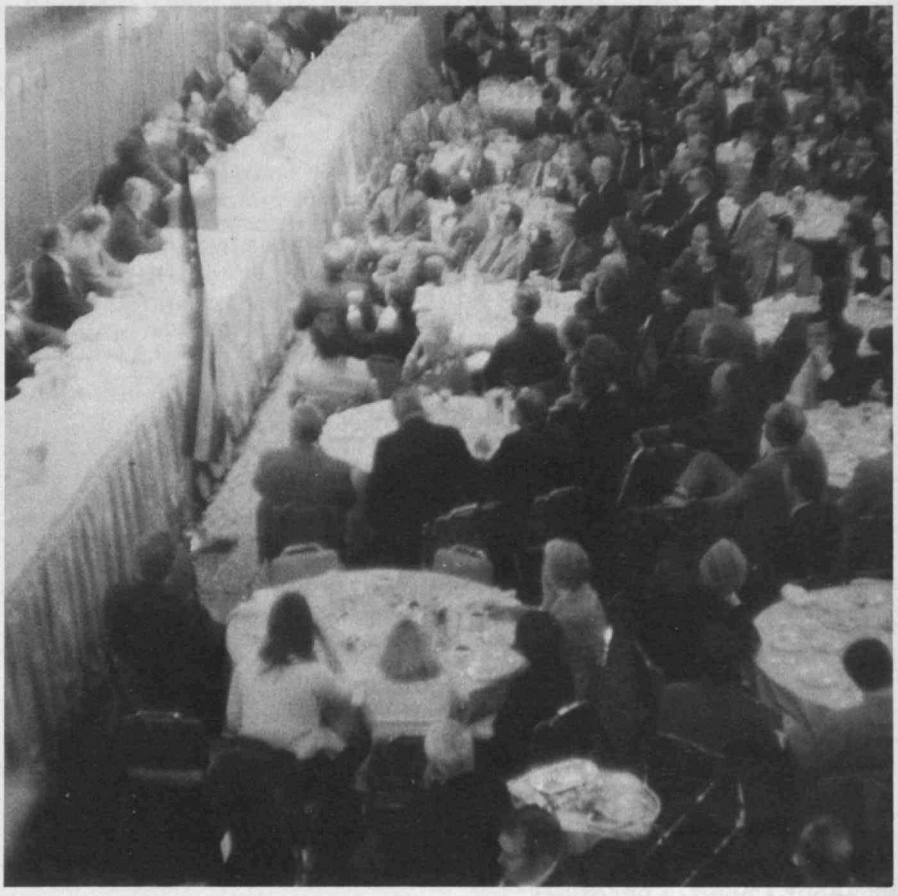
—Price controls must be structured to let market forces work whenever they will to increase—not decrease—supplies.

—Try to focus on the "true" sources of inflation, not the superficial ones. Among the former, thinks Professor Mills, are "government-operated but industry-inspired restrictive practices in agriculture"—planting limitations, import restrictions, and the like; the failure to control health service costs; policy changes which lead to expensive stop-and-then-go production and investment patterns; the gap between "schooling and the world of work" which leads to unemployment among young people; the American economy's susceptibility to "short-term, discretionary acts" of foreign governments. Summarizing the executive's problems in an era of crisis and shortage, William B. Johnson, Chairman and Chief Executive Officer of I.C. Industries, Inc., used words like "multiple," "diverse," "inconsistent", "new in kind and degree," "political," "psychological." For many executives, he said, it all adds up to "uncertainty, which is the enemy of efficiency."

William J. Weisz, President of Motorola, Inc., has a forthright answer: "No amount of talking will take the place of work and honesty." Among our scarcities, he said, is "public confidence in business," and to overcome that one "you absolutely must act responsibly."

William F. Pounds, who was host at the seminar as Dean of M.I.T.'s Sloan School of Management, chose a more fundamental (academic?) view. "Managers have always dealt with scarcity," he said, "—of materials, motivation, confidence, understanding . . ." The problem is changing only in intensity, and our response need only differ in the same way: let us "admit the size of the gap between what we know and what we need to know" and then set about to close it.

For example, he said, we assumed that a nation able to land on the moon could as well improve its cities and manage inflation and reduce unemployment. Now we know differently, that we need "a long-term, steady commitment of resources for the analysis of our basic problems" and for the education of people to do the job. —J.M.



William F. Pounds (left in the small picture), Dean of the Sloan School of Management, brought his convocation to Chicago for John W. Barriger, IV, Assistant to the President of Santa Fe Railway (right), at a time when "public confidence could hardly be lower," a time when "everyone is subject to suspicion (of) . . . restraining progress." Business has always lived with scarcity, but the environment of suspicion is new, Dean Pounds thinks, and so therefore is "the size of the gap between what we know and what we need to know." Hence the 1,200 people listening to a pessimistic Professor Paul A. Samuelson at lunch: "We simply don't know how" to cut inflation below 8 per cent a year.

Classified

PROFESSIONAL

THE BULLETIN OF THE SCIENCE FICTION WRITERS OF AMERICA is now accepting outside subscriptions. Market and convention reports, news of SFWA activities and the sf publishing field, photos of authors and events, articles by leading sf writers. Bimonthly. $10/yr, $18/2 yrs. SFWA, Box 227X, Chinchilla, PA 18410

PERPETUAL CALENDAR OF THE FUTURE!! With 14 artists' conceptions. Perfect gift. Send $3 each to Future Calendar, Box 1169, Nashua, N.H. 03060

INCREASE YOUR GOVT. SUPPORTED R&D ACTIVITY

Twice monthly report on sources of Federal support for R&D projects. Sample copy: Government R&D Report, MIT Sta., P.O. Box 284, Cambridge, MA 02139

HOW TO EARN MONEY AS A CONSULTANT $13 (including specimen contracts) Business Psychology Int'l 342 Westminster Avenue—Suite 228-13 Elizabethtown, New Jersey 07208

WANT TO KNOW MORE ABOUT THE FUTURE??
For news of the late 1970's, 1980's, and beyond read this unique newsletter every third Monday. 18 Issues/$36 YR

FUTUREPORT

Box 1169, Nashua, NH 03060 Sample on Request

THE GEOMETRY OF ROTATIONS ABOUT A POINT: A PRACTICAL TREATISE. 7.25 ppd. SPHERE GRID 2.50. M.B. Guar., Free lit. Felstein, Rt. 1 Box 126, Albany, Oh. 45710

INDIAN COVE

FOR LOVERS OF NATURE AND THE SEA

We have formed a coastal community in Marion, Massachusetts, based on principles of environmental preservation and the protection of open land. In some ways we are like an ordinary land developer (we have 60 house lots for sale); in other ways we are quite unusual (of our 200-acre tract, 125 acres are to be protected as open conservation land). It's an interesting story; send for our free, 24-page brochure to get all the details.

INDIAN COVE TRUST
Tower Building, Marion, Massachusetts 02728

Productivity

..hypothesis two.. incorporated

THOROUGH PATENT AND TRADEMARK SEARCHES for Professional Engineers and Research & Development firms.

PATENT CONSULTANTS
422T Washington Building
Washington, D.C. 20005
(202) 638-1666

FOR RENT

PORTUGAL-ALGARVE. Villa overlooking sea. 3 bedrooms, 2½ baths, maid. Golf, tennis. Weekly, monthly. Harrison, 1 Harris Pk., Red Bank, N.J. 07701. 201-747-1159

FOR SALE

ELECTRONIC PUZZLE: LED Indicators. $14.95 ppd. INSTRACON, P. O. Box 702, Benton Harbor 1, MI 49022

JOB OPPORTUNITIES

We have been placing B.S., M.S. and Ph.D.
ENGINEERS
in **fee paid** positions (to $25,000) throughout U.S. since 1959. Send resume and salary history today or request application.
A. L. KRASNOW '51 Pres.
ATOMIC PERSONNEL, INC.
Suite T, 1518 Walnut St., Phila., Pa. 19102
Employment Agency For All Technical Fields

Classified Ads: $2.80 per line; two-line minimum. (Allow 35 letters & spaces for first line; 40 letters & spaces for each additional line.) **Display Ads:** $25.00 for first column inch; $20.00 for each additional inch. Frequency rates available. **Copy Deadline:** one month prior to publication date. Payment in advance of insertion required for less than three insertions in one year. Send orders to: Classified Section, *Technology Review*, M.I.T., E19-429, Cambridge, Mass. 02139.

Letters

Continued from page 4

Wanted: Environmental Scholarship

For years, and through a variety of channels, I have argued the case for a quality environment as a sound business proposition. The most conspicuous product of this effort has been a sense of futility. And now I know why. I have counted too much on intuition, too little on scholarship. The thought occurs that despite the proliferation of high-minded (and high-priced) seminars for business executives, I know of none that has demonstrated, with James Brian Quinn's (*see June, pp. 30-39*) kind of precision, the economic possibilities inherent in environmental improvement and life quality. I would like to see such a forum developed, in which the sophisticated communications tools and techniques of corporate outreach are smartly employed.

William Houseman
Bronx, N. Y.

Mr. Houseman is Editor of The Environment Monthly, *a publication of the Environment League, Inc.—Ed.*

Oil and Ice: Complexities

During the course of the clean-up at Chedabucto Bay in Nova Scotia, we had considerable experience with the problem of oil spilled in freezing sea water, and our findings suggested a degree of complexity not covered in the work of Professor Hoult and Mr. Wolfe (*"Hopeful Findings on Oil and Ice," February, pp. 73-74*).

From my personal observations, while the ice was forming at Chedabucto Bay, one had oil thrown on top of the ice over substantial areas by the action of strong winds and major transient storms, one had the ice forming underneath the oil, and one had the oil driven underneath ice that had already formed. In addition, there was what in our jargon was called "brown ice," which was the entrainment of oil particles in the ice—sometimes particles that were quite small, sometimes particles that were as large as a five-cent piece, the latter giving the ice the appearance of being rice-pudding with too many raisins in it. The oil content of this ice varied from about 0.5 percent to a maximum of 4.5 percent.

I would imagine that the difference between our observations and the carefully controlled experiments of Professor Hoult and Mr. Wolfe results from the rather boisterous weather that prevails in Chedabucto Bay during the months of February, March and April when we were struggling with the ice and oil.

Paul D. McTaggart-Cowan
Ottawa, Ontario, Canada

Dr. McTaggart-Cowan is Executive Director of the Science Council of Canada. —Ed.

Some Athletic Recollections: Was 1973-74 Really the Worst?

In the July/August issue (*p. 97*) you record *The Tech's* judgment that the 1973-74 basketball season was "the worst in the school's history." I'm not so sure. Referring to *Technique 1902*, I find that out of 11 games we won 3; but we did lick Harvard. *Technique 1903*: six games, we won 0. I played guard on that team. *1904*: apparently no team. *1905*: nine games, won six, including Holy Cross, Brown, Amherst, and W.P.I.

I was manager that year and well remember that in practice before a big game, someone fell on the ball and busted it beyond use. The next morning I walked down to Major Briggs' office, 10 High Street, got some cash, went over to Wright and Detsons, got a new ball, and dribbled it all the way back to Rogers.

Our gym was an old Boston and Albany freight shed on Exeter Street. We couldn't have home games because there was no room for spectators. But it was fun.

Fred W. Goldthwait, '05
Center Sandwich, N.H.

An Insensitive Appraisal of Course Evaluation

I strongly object to your insensitive article on the 1974 Course Evaluation Guide (*"Course Evaluation," March/April, pp. 88-89*). Course evaluation at M.I.T. serves to give faculty feedback about the quality of their teaching as well as to give students summary evaluations to help them plan their curricula. As a teacher, I find the unedited student comments written on the questionnaires quite helpful and for that reason welcome evaluation. The student-prepared summary published in the Guide is less helpful to me but is presumably useful to students interested in my course.

Certainly your readers appreciate understanding this evaluation process; but how do they possibly benefit from learning the names of four of us selected from the Guide by you as random examples of "bad" teachers? I care about undergraduate education and even though I think the inference is untrue, it still hurts. It also seems unjust to quote the negative comments about my teaching from the Guide but to omit the positive statement made there that "it is a good course for a general background in oceanography." How can a good course (in which most of the material is presented through the lectures, without a principal text) be the product of such "bad" teaching?

Robert C. Beardsley
Newtonville, Mass.

The author is Associate Professor of Oceanography at M.I.T.; the Review welcomes his comment, accepts his criticism, and offers—as best it can—its apology for making personal what should have been an impersonal report on student evaluations.—Ed.

Laboratory Management From the Other Side

In reviewing John R. Coleman's *Blue Collar Journal* (*July/August, p. 62*) recounting the author's experience while on a sabbatical, Howard W. Johnson writes that "most industrial managers could profit from a similar experience." He is quite right. As a research manager who started work as a laboratory dishwasher/animal-caretaker some 30 years ago and earned the necessary academic qualifications at intervals along the way, I find my understanding of, and approach to, laboratory management quite different from that of my colleagues who entered the real world with a Ph.D. or M.D. but with no experience at the bench. It would seem that such an experience would lead to some insight as to the motivation, hopes, and dreams of those upon whom our own success is dependent. One might even learn that not everyone is trying to be shrewd and calculating, that most people are doing their jobs the best they can, making their contribution in their way. Success has many faces.

John J. Gavin
Elkhart, Indiana

Thinker, Friend, Adviser, and Confidant

The late Samuel J. Mason (Sc.D. '54) (*see May, p. 86*) was one of my professors in undergraduate courses as well as my graduate thesis advisor, and I came to know, admire, respect and love him as a great thinker, friend, personal advisor and confidant. My present occupation frequently takes me to Boston, and I never hesitated to make a visit to Sam my No. 1 priority. Sam provided me with great insight into both myself and the world, insight which has to a great extent dictated my relationships with other individuals. Perhaps the one episode which best typifies my remembrance of the man occurred on the day that Norbert Wiener died. At that time, Sam, with tears in his eyes, found it impossible to continue with the teaching tasks at hand and instead related to the class incidents concerning the man he had come to know, admire, respect and love. I only wish that I had the same opportunity today.

Bruce P. Golden, '65
Chicago, Ill.

"Mr. Shaw, Won't You Come In?"

The late Vannevar Bush (Eng.D.'16) (*see pp. 66-69, July/August*) was a brilliant engineer and scientist, but he was not a very good teacher. I took a course under him once where I was the only student in the class. He told me, not once but several times, that I was the dumbest student he ever tried to teach. I passed the course, but I have an idea that all I had to do to get a passing grade was to sign my name on the examination paper. Later in World War II I ran a war plant. I happened to be in Washington in one of those many buildings and passed a door marked Vannevar Bush. I stopped and went in and said to his secretary, "Tell Dr. Bush that the dumbest student he ever tried to teach would like to pay him his respects." She smiled and went into the inner office and then came out. "Mr. Shaw, won't you come in." Van swears that did not happen but I know it did.

Ralph M. Shaw, Jr., '21
Beverly, N. J.

"Just have a good time during R/O week. You'll probably end up liking wherever you decide to stay."

Institute Review

In This Section

The Class of 1978

The serenity of summer gives way to the hustle of fall as a record Freshman Class explores the highways and byways of M.I.T. and Boston (*page 99*) . . . President Jerome B. Wiesner tells them about the dangers of "tooling" (*page 99*) and finds the freshmen "highly motivated" and "gregarious" (*page 101*) . . . The new Class includes more women than ever before, and Baker House goes coed to help meet a housing crunch (*page 102*) [Margaret E. Page, '78, is shortly quoted by *The Tech* as saying, "I like the homey atmosphere—the other dorms were sterile!"] . . . And Elizabeth Cavicchi, '78, writes that her "greatest delight" in her first week at the Institute is the students' "open friendliness" and "their capacity for deriving nothing from nothing just for the glory of it" (*page 103*).

News and Views

—M.I.T.'s final Affirmative Action Plan sets specific employment goals as well as broad statements of principles (*page 104*).

—A new survey reveals the major economic impact of higher education in Boston (*page 105*).

—How some young M.I.T. people are helping achieve "a formal union of gerontology and architecture" *(page 106).*

—Prizes come to M.I.T.'s landscaping (*page 107*) and our magazine (*page 108*).

People and Places

—An M.I.T. coed breaks another "sex barrier" as the first summer groundskeeper (*page 109*).

—Two new leaders for the Department of Urban Studies and Planning say their job is to find some "systematic organization" for "a lot of new information" (*page 110*) and a new Head for Mechanical Engineering wants to stress the practical unity of all engineering (*page 114*).

—Maggie brings her "beautiful machine" (*page 110*) and Leonard Bernstein his ideas about music, science, and aesthetics (*page 112*) to M.I.T.

The Class of 1978: Bigger, More Women, and Plenty of Poise and Self-Confidence

The Class of 1978, which entered M.I.T. after a 12-day Residence/Orientation (R/O) Week between August 28 and September 10, holds at least four distinctions:

—The class size (1,038) was exceedingly greater than last year's and somewhat greater than advance estimates, causing temporary over-crowding in the dormitories.

—There are 214 women in the class—20.5 per cent of the total, the largest percentage ever.

—594 (90.5 per cent) of the 657 freshmen placed in Institute houses ended up in the house of their first choice—another record. "Coedity" came to one more dormitory, Baker House.

—Fraternities were successful with this year's rush; 361 freshmen and 18 transfers pledged, 97 per cent of the estimated goal.

R/O Week proved an exciting trek into the wilderness for freshmen and freshwomen as they unloaded their carefully packed bags and boxes and scrambled all over the Institute, some frantically searching for "Building Thirty-what?" and exclaiming "*This* is Building 10 lobby!?"

Before the official start of rushing, the freshmen, their advisers and associate advisers, and various representatives of the different houses were treated to a free meal at the Freshman Picnic, which was moved from Killian Court to the Du-Pont Armory due to unscheduled rain. Although cramped in the steamy gymnasium, the freshmen never ceased to be high-spirited; they laughed at all the familiar, but welcome, jokes and words of advice from the speakers: R/O Chairman David A. August, '75, Undergraduate Association President Steven M. Wallman, '75, Dean for Student Affairs Carola B. Eisenberg, Freshman Picnic Coordinator Barry M. Brian, '77, Dormitory Council Chairman Thomas J. Martin, '76, Intrafraternity Conference Chairman Peter J. Mancuso, '75 and President Jerome B. Wiesner.

It was President Wiesner who warned the new freshmen against "working too hard—or at least too singlemindedly." He admitted that lots of alumni tell him the thing they most value from their M.I.T. experiences is "learning to work hard," but the point, said Dr. Wiesner, is "to get a broad range of experiences and let all of your talents and the many sides of your personality develop.

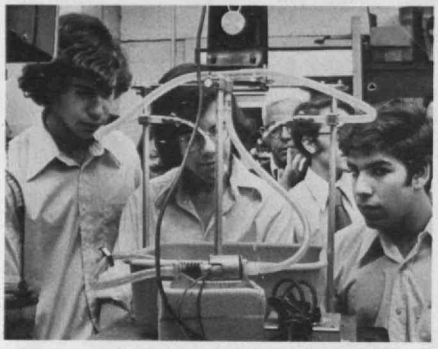
"For life, if it is to be satisfying," said Dr. Wiesner, "demands from us an appreciation of other people and of many things—of creative skills, values, a taste for the best, a sense of beauty and a sense of humor, an understanding and a perspective of the whole complex environment in which we live."

Rushing by Computer

Once the fatal words, "Rush Week has begun," were uttered, hordes of future pledges streamed out the doors into the clutches of the fraternities who virtually offered them wine, women, and song with variations on the theme. Noticeable among the signs were Theta Chi's "Breakfast of Champions," advertising a steak-and-eggs breakfast for freshmen, Sigma Chi's broken Tech oar holding their call letters aloft, and strains of band music provided by some obscured, but not obscure, fraternity.

Then there was the question of keeping track of the wandering freshmen—whom some would prefer to call "fresh-people"—but the technology for which M.I.T. is well known quickly solved that problem: One distinction which separated this year's entering class from last year's was Clearinghouse's use of a computerized system to replace the outdated punch cards and standard manual systems, the new system being the product of a year's research by M.I.T. upperclassmen, James R. Miller, '76, John D. Sybalsky, '75 and Robert H. Hal-

"Choosing a career at M.I.T. is like browsing in a hardware store and saying: 'Gee, just think what I could do if I had all that stuff.' "



"You can be too concerned with the employment value of your courses. Just learn what you want to learn. M.I.T. is a name which will open all kinds of doors; you don't need to worry about it now."

R/O Week began with fraternities rushing, tours, and the Freshman Picnic; new arrivals included 27 students from Project Interphase, 214 women, and 36 foreign students.
(Photos: this page, Calvin Campbell, from *Tech Talk;* and Richard Reihl; on page 100, Calvin Campbell, from *Tech Talk;* and on page 98, Chris Santos)

stead, '75. It is a modification of the TENEX system owned by Bolt, Beranek and Newman of Cambridge, contributors of more than $1,000 in phone lines and terminal time to the R/O Week Clearinghouse. The on-line system was also made possible by a grant from the Dean's Office Special Projects Fund; and M.I.T. provided additional lines to service the 29 fraternities involved in the system.

As each freshman/freshwoman entered a fraternity, (s)he was obliged to sign into a check-in/check-out book, jotting down his or her name, time in, time out, and destination. Once that was done, the information was sent to the Clearinghouse via the computer system so that in case a member of the Class needed to be found, data on his/her whereabouts could be obtained almost immediately.

Although there were no major infractions of the rush rules (last year Sigma Alpha Epsilon was fined $400 "for conduct detrimental to a rushee" when a bidee, eager to pledge, was discouraged from pledging by S.A.E.s who told him his joining would overcrowd the house), there were minor violations in houses where freshmen visitors forgot to sign in at all. Nevertheless, the system seemed to be a success its first year and will probably be used again next year.

Besides fraternity parties and dormitory open houses, there were the annual Academic, Activities, and Athletic Midways—the organized opportunity for faculty and activities to attract the interest of the freshmen. (John Buttrick, the Head of the Music Division, likens the Academic Midway to a slave market in which the faculty are on display to would-be buyers.) Not to mention the numerous tours of surrounding areas such as the Museum of Fine Arts, downtown Boston, Kendall Square, Haymarket (which one freshwoman remembered as "so beautiful, with lots of different vivid colors") and a Pub-Crawling Tour, now that the drinking age is 18 in Massachusetts. Closing festivities included an eight-hour block party on Kresge Plaza, a look into the class' future with the movie "The Graduate," meeting other freshmen and their parents—this time in a more formal atmosphere—at the President's Reception, and, finally, Registration Day and the fifth semi-annual Rock Revival at the Student Center.

Interphase: Easier Entry

Long before the freshman class had arrived at the Institute, long before the R/O Committee was setting up the Clearinghouse, long before the fraternities' Work Week, 27 freshmen had a very special initiation into the ways of M.I.T.

Project Interphase, a seven-week summer academic program primarily for minority students, ran from June 23 through August 9. Designed to ease the transition from high school into the M.I.T. classroom for students without complete academic preparation, the program consisted of classes in physics, calculus, chemistry, expository writing, study skills, art and photography, and the use of Institute resources and tutors. "Getting acquainted with the system," is how one participant, Bernice M. Williams of Houston, Texas, described the program to *Tech Talk.* And did Bernice enjoy herself? She admitted that she spent a great deal of time working, "but I believe I've benefited from it. In fact, I wouldn't have passed it up for anything."

"Excited" and "Highly Motivated"

Everyone at M.I.T. seems to be delighted about the Class of 1978. President Jerome B. Wiesner told the Administrative Council just after Registration Day that he was "enthusiastically pleased by the number of excited, highly motivated students. . . . A particularly gregarious group with a high level of poise and self-confidence," he said. They should have no problem holding their place in M.I.T.'s history.

The Class of 1978 literally covers the universe. There are 63 minority students, freshmen from 46 states, from Canada, and from 35 other countries. More of the

Class are from New York—231—than any other state. Next comes Massachusetts—125. Eleven are from the Bronx High School of Science, 10 from Stuyvesant High School. The range in age is 15 to 18.

According to Peter H. Richardson '48, Director of Admissions, the Class of 1978 was selected from some 4,300 applicants, a 20 per cent increase from the year before. Early last spring M.I.T. announced that it wanted a class of 1,000 this fall (*see* Technology Review *for March/April, p. 85*). But 3 per cent more than this finally materialized; what Mr. Richardson calls the "summer melt" was smaller than usual. Why? No one is sure; perhaps the widely publicized news that engineers are in short supply and will be throughout the 1970s, perhaps some special sense of M.I.T.'s current relevance.

"When they tell you to hold onto your yellow form, guard it with your life or you could be stuck here another term."

The Housing Crunch

With 1,000 students in the Class of 1978 the Institute houses could have been packed full. With 1,038, they are overcrowded. It was at its worst as R/O Week started, but as fraternity pledges moved out, the jam-packed houses eased. Those freshmen who were in limbo (meaning temporarily quartered: "Limbo is not coed," Assistant Dean for Student Affairs Kenneth C. Browning '66, informed Storm Kauffman '75, of *The Tech*) gradually moved into doubles-turned-triples, some in Senior House and East Campus, others in Bexley, which was alarmingly undersubscribed. In fact, the 29 members of the Class in Bexley had listed the house as less than their fifth preference or not at all.

As the dust settled on housing, some 60 students beyond the nominal capacity were living in the houses, and transfer students and undergraduates who had moved off the campus and wanted to move back simply were not being accommodated at all.

"Coedity"—*The Tech*'s word-saving term that needs no definition and would find none in any legitimate dictionary—came to Baker House this year, leaving three Institute houses still accommodating only men or women: Bexley (men), MacGregor (men), and McCormick (women).

Now there is a plan to alleviate the room shortage by placing upperclasspeople in the homes of faculty and staff members. As Mr. Kauffman reported, "Mildred S. Dresselhaus, Professor of Electrical Engineering who is one of the faculty involved, told *The Tech* that she had been 'pushing this idea for some time.'" Although about 40 faculty and students have expressed interest in the program, handled through the office of Vice President Kenneth R. Wadleigh, '43, only one placement of a student-faculty pair has been made. David H. Lockwood, '75 has moved into the home of Associate Professor of Humanities William B. Watson; his living expenses on campus were too high, and off-campus housing carried with it the disadvantages of obnoxious landlords, penniless roomates, and monthly utility bills. As Mr. Lockwood told Mr. Kauffman, "I have a good deal and don't want to lose it."

As Mr. Lockwood's host, Professor Watson is eager to have a student share his family's large house in nearby Arlington, hoping that the family situation will prove to be a "nice environment for the student."

Financial Aid Requests Higher

Tuition costs have been affected by inflation, the number one, nation-wide enemy. And for the second consecutive year, the number of entering freshmen who requested financial aid was higher than the number of students who did not. Nevertheless, the Financial Aid Office was able to maintain last year's equity at $1,750 per student. Scholarship funds totaling $3 million from all sources, inside as well as outside the Institute, made it possible for Jack H. Frailey, '44, Director of Student Financial Aid, to say that "we have a strong program this year."□

More Students, More Engineers, More Women

A freshman class larger than last year's by some 130 students represents most of the difference between M.I.T.'s enrollment in 1974-75 (7,749 undergraduate and graduate students, as of October 1) and that of a year earlier (7,580).

Graduate student enrollment is down slightly—3,649 this year compared with 3,775 last year.

The largest school continues to be the School of Engineering, with 1,132 undergraduates and 1,735 graduate students—up 136 students from last year. The School of Architecture and Planning, with 195 undergraduates and 272 graduate students, also showed a gain this year—29 more than a year ago. Other October 1 enrollments included the School of Science—1,095 undergraduates and 984 graduate students; the School of Humanities—115 and 283, respectively; and the Sloan School of Management—113 and 375.

The Department of Electrical Engineering remains M.I.T.'s largest—1,220 students as of October 1.

There were 921 women enrolled at M.I.T. last year; this year the number is 1,061—625 undergraduate and 435 graduate students.□

Labyrinthine Buildings and Upward Bound Unicycles: A Freshperson Mythmaking at R/O Week

Technology Review *asked Elizabeth Cavicchi, '78, of Fairview Park, Ohio, to write about her impressions of R/O Week for this month's issue. Among Elizabeth's high school interests were poetry writing, sculpting, and experimenting with light waves, and she has not yet chosen a field in which to major at M.I.T. (Her father is Richard H. Cavicchi, '44.)*

As a not-quite freshperson, I entertained myself this summer by preimagining M.I.T., shifting between moments of terror and anticipation. I found myself vacillating in an uncertain limbo, enthralled and intimidated by a theoretical acquaintance with the school. Why should M.I.T. want a girl who chases rhinoceros with a lariat jump rope? But scattered through the freshman correspondence were reassuring rumors of a fable-obsessed student body. Maybe the school really would be human—sensitive to such games as cloud-jostling and word springing? I clutched these ambiguous promises, packed my bags and set out for the bright lights of Cambridge.

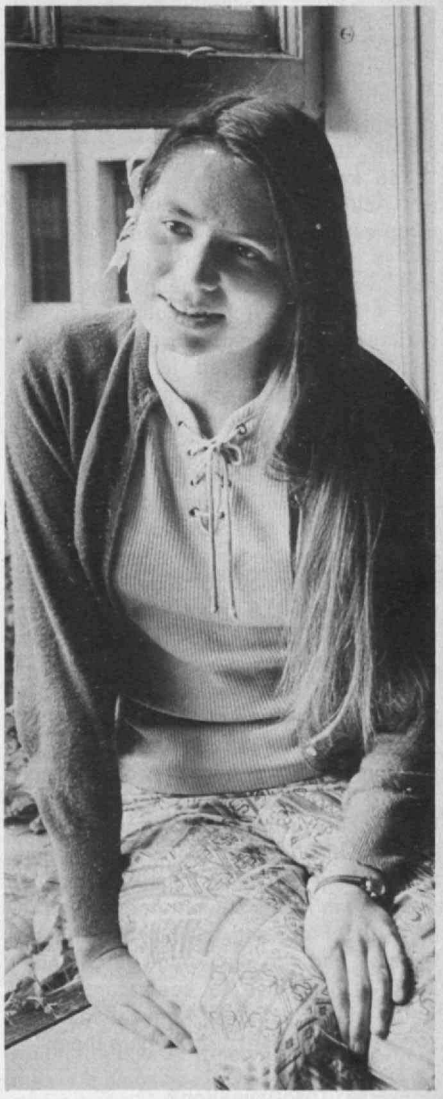
To my delight, I found during R/O Week that mythmaking is a passion at M.I.T. and I was easily captivated by a conspiracy whose password was "freshperson." By uttering this single word, I was privileged to enter this world infiltrated by a network of legend, invigorating M.I.T. with its own mischief.

Even the Charles River nearby reeks of "hacks." One upperclassman offered to christen me with a vial of the polluted water to inspire me with M.I.T.'s roguish ingenuity. (This may be why "riverview" rooms are so desirable here; you can get free inspiration every time you look out the window.) Spanning the river, the Harvard Bridge is measured in "smoots": body lengths of some reveling hero (364.4 plus one ear, to be exact). At midpoint, there is a warning: "Halfway to Hell," preceded by the numbers of the various classes—'75, '76, '77, '78, and old number '69.

One of the several "exotica" tours held during the week conducted me over the small dome of Building 7 and down into the murky vaults of the "Tomb of the Unknown Tool," thus permitting two perspectives of life at M.I.T.: the tentacled dome-clinging, and the "barely-squeezed-through" sensation inside the narrow maze of pipes and dirty walls. Could this be symbolic of the alternative forms of surviving in classes? Perhaps, but thoughts of exams and papers are brushed aside during R/O Week; we were just a gang of 1,038 mooching freshmen intent on acquiring other skills and developing our latent aptitude for "random operations." We weren't students, but potential pranksters, ready for fun. Selecting dormitories, we worked heady triumphs by delicately balancing our choices with a power of decision that could even control and intimidate upperclassmen.

My greatest delight this week was the student body. I valued their open friendliness, and their capacity for deriving nothing from nothing just for the glory of it. They were particularly eager to recognize the freshwomen (20 per cent), as the popularity of picnics and ice cream parties proves. It was encouraging to be among such a company of women; we were not isolated or a self-conscious and rare commodity, but simply people. I easily skipped through this atmosphere of warmth, living up to Dean Carola Eisenberg's wish that we be "happy."

And I began to realize that M.I.T. defies logic: unicycles proceed *up* stairways here, and buildings, sometimes rooms, are laid out in labyrinthine order. (Why isn't Course 18 in Building 18?) Students playfully cultivate the esoteric M.I.T. language, relishing its deliberate confusion and oblivious to its peculiar convenience. I believe this playful determination encourages our manipulative growth during the transition from high school to college; the step is great. And so, most significantly, during R/O Week at M.I.T., many of us enjoyed the freedom we missed at other schools: freedom to think, to create, and even to turn handsprings atop Kresge dome.



Elizabeth Cavicchi

Affirmative Action: Goals Set, Plan Approved

In November, 1970 there were 17 women among 947 members of the faculty at M.I.T. (1.7 per cent). Four years later, in September 1974, there are approximately 970 faculty with 51 women or 5.3 per cent. By 1975, according to M.I.T.'s final Affirmative Action Plan filed with the Department of Health, Education and Welfare in March 1974 and officially accepted by H.E.W.'s Office for Civil Rights, there will be 69 women in a faculty of just over 1,000—7 per cent.

The figures for minorities on the faculty are smaller—for example, 16 blacks in September of 1974, with a goal of 31 by July, 1975.

The key concept in M.I.T.'s Affirmative Action Plan is "to achieve at M.I.T. a representation of women and minorities that is at least in proportion to their current availability." This means that in setting Affirmative Action goals, each department and administrative office at the Institute has surveyed its present and likely future openings and has studied the proportion of minorities and women in the internal/external pool qualified to fill each available position.

The number of blacks projected to be on the faculty by 1975, for example, is small because blacks are a small fraction of the total number of qualified professionals in the U.S. from which new faculty can be chosen (particularly in the areas of science and engineering).

Two other policies are also basic to M.I.T.'s Affirmative Action Plan:

—To provide for all employees new opportunities for career development "which both stimulate and respond to their changing interests and aspirations."

—In the Institute's educational programs, to "achieve representations of minorities and women in the student body which reflect their current availability and interests" and "to encourage larger numbers of minorities to seek careers for which the Institute's educational resources are designed to prepare them."

"Reverse" Discrimination?

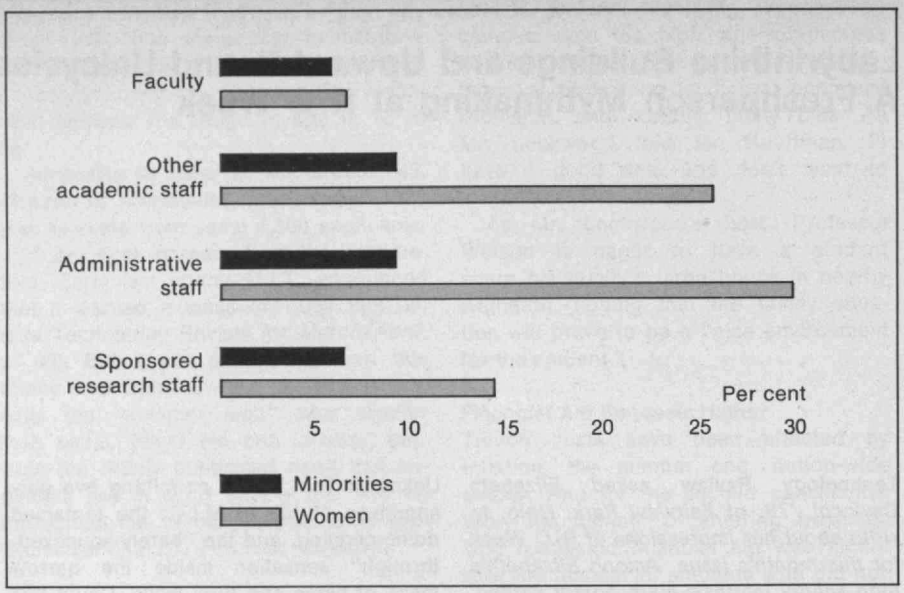
Will the assignment of numerical goals for faculty, staff, and students lead to reverse discrimination and lowered standards for choosing staff and students?

M.I.T. is determined that this will not happen. Patricia A. Garrison, Assistant to the Equal Employment Opportunity Officer, thinks it is basically a matter of the criteria used to measure candidates—to emphasize the future potential of each person rather than focus principally on past experience.

And James J. Culliton, Personnel Services Director, emphasizes flexibility. "We don't intend to have a system so rigid that rules can't be subject to judgment on an individual basis," he says. There must be some flexibility in any successful system and we attempt to develop procedures to assure that this is the case. Furthermore, he says, the Affirmative Action Plan requires "vigorous and systematic efforts" to identify qualified candidates. Never before has such a requirement been so explicitly stated, and the pool of candidates from which new appointments are made is likely to be larger than ever before, the chance to select the best available people for each vacancy greater than ever.

Everyone at M.I.T. must have a role in affirmative action, thinks Ms. Garrison: All members of the Institute community should understand the plan and interpret it in a "very broad sense" to educate others about its goals and its implementation.

Alumni can be helpful, too, she thinks—in "raising the consciousness" of eligible candidates as students and for staff and faculty positions, and in identifying such candidates to persons responsible for employment or admissions at M.I.T. Mr. Culliton emphasized that, "although the plan has received widespread commendation, its effectiveness will be in implementing the objectives outlined in the plan.□



Under an Affirmative Action Plan approved this summer by the Department of Health, Education, and Welfare, M.I.T. is pledged "to recruit, admit, employ, promote, and reward women and minorities (Black Americans, Indian Americans, Oriental Americans, and Spanish-surnamed Americans) to a degree consistent with their availability and merit." Each department and administrative office, having surveyed its probable needs and the number of minorities and women trained in the fields of its concern, has set goals for its employment of such people by July, 1975; the Institute's Affirmative Action Plan sums these goals to show (above) the percentage of women and minorities to be employed in each category by July 1, 1975.

To Strengthen the Role of Women at M.I.T.: A New Faculty Chair

Alumni participating in the 1975 Alumni Fund will be able to help the Institute increase opportunities for women in science and engineering: a major goal of the Fund is to complete the Ellen Swallow Richards Professorship, for which about $500,000 is needed.

The Richards Professorship was announced by President Jerome B. Wiesner in June, 1973, at the celebration of the centennial of Mrs. Richards' graduation. She was the first woman to receive an M.I.T. degree. The chair will be reserved, Dr. Wiesner said, "for distinguished women members of the faculty," and he said that most appointments to it would be of M.I.T.'s own alumnae. The purposes: "to recognize the national importance of contributions by women to research and education at M.I.T., to honor the pioneering spirit and professional achievement of Mrs. Richards as the first woman to hold membership in the M.I.T. faculty (she joined the Department of Chemistry in 1878 and served with distinction until 1911), and to strengthen the role of women in the Institute's faculty."□

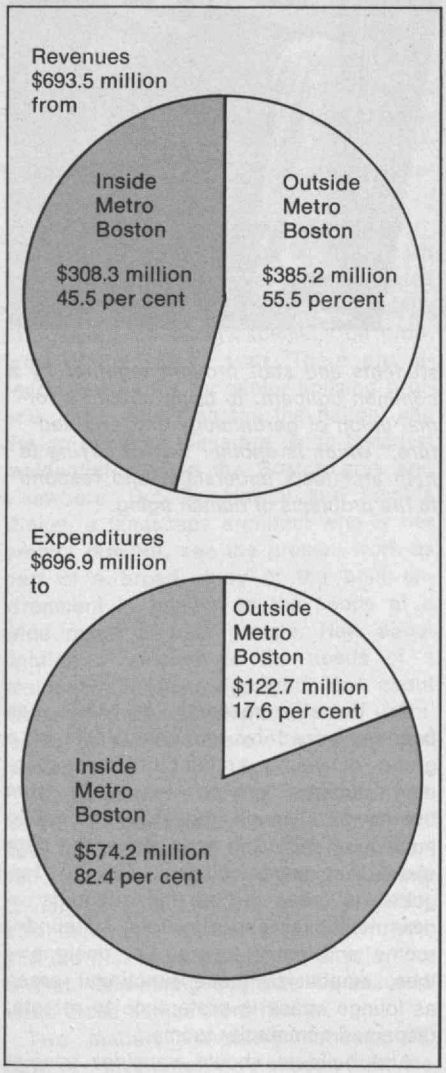
Education: A Major Plus for Boston

The 65 colleges and universities in metropolitan Boston are a concentration probably unequalled in any other region of similar size and population in the U.S. Is this a "good" thing, or a "bad" thing, for Greater Boston?

The unequivocal answer in a new report commissioned by the Presidents of eight Greater Boston universities: a "good" thing, because "metropolitan Boston's universities and colleges have a major economic impact upon the area.

"The bulk of the money spent by the universities, their employees, and their students is spent in metropolitan Boston and is of important weight within the local economy. And university revenues and students and visitors from out of town draw large amounts of money into the area from elsewhere, much of it from out of state.

"The education community is, in effect, a major local 'export' industry, bringing prosperity to the local economy," says the report.



Greater Boston's colleges and universities are a major factor in the region's economy because they "import" far more money than they "export." According to a new study, less than half of the funds reaching eight major Boston universities in 1972 came from within the Greater Boston area, but 82 per cent of the universities' expenditures were made within that area.

1.3 Billion: "Vital . . . in the Economy"

Concerned that the contributions of their institutions to the economy of Greater Boston be better understood, the presidents of Boston College, Boston University, Brandeis, Harvard, M.I.T., Northeastern, Tufts, and the University of Massachusetts in 1972 commissioned the SDL Systems Research Group of Toronto to survey the impact of Boston-area colleges and universities on the local economy.

Transmitting its results, George Mowbray, SDL's Project Director, said late last spring that "the most significant finding of the study is the importance of higher education's monetary expenditures in the economy of Greater Boston." Those expenditures—including operations, students, visitors, and construction programs—are $1.3 billion annually, and they are "vital elements in the regional economy."

The economic gains stem from a simple fact: the eight sponsoring universities' annual revenues, which totalled more than half of $693.5 million in 1972, came from outside the area; but only 17.6 per cent of their expenditures, totalling $697 million, were made outside of Boston.

The faculties and staffs of the 65 institutions of higher education in Greater Boston had $239 million of disposable income in 1972, and 82 per cent of this was spent in Greater Boston. These institutions' 70,000 full-time students spent $156 million in 1972, 94 per cent of it ($146 million) in Greater Boston.

The universities and their faculties, staff, and students are "an integral part of the financial fabric of Greater Boston."

Inequalities and Disadvantages?

Unfortunately, these benefits are not equally shared, said Mr. Mowbray. Universities are exempt from real estate taxes, which in Massachusetts are the principal sources of revenue for cities and towns; the universities' economic effects are principally reflected in their employees' and suppliers' income tax payments to the state. Thus "the host cities do not receive any substantial fiscal benefits from the income generated by colleges and universities, and therefore the argument," says Mr. Mowbray, "for state aid to cities to compensate them for the property tax exemptions granted to colleges and universities."

What disadvantages for Greater Boston offset the economic advantage of colleges and universities? Only two are cited by the SDL report:

—Universities demand municipal services—police and fire protection, street and sewer maintenance, public health services, etc. But the exact cost of these services simply cannot be measured: "we have found no methodology capable of sorting out these complex variables," says the SDL report. And it notes that payments in lieu of taxes are made by some Boston-area institutions to help the host cities meet these costs.

—Colleges and universities bring with them "potentially disturbing effects on the local lifestyle," by which the SDL report means crowding of housing, transportation, and places of entertainment, and "the exuberances that a young student population displays."

A small price for prosperity, concludes Mr. Mowbray and his associates.□

Major Findings of the Economic Impact Study

Employment

Boston ranks number one in the country with 9.6 per cent of its work force engaged in educational services. Of the 109,000 people involved in educational services, 40,000 are employed in post secondary education.

Operating Expenditures

Of the $1.3 billion contributed to the Massachusetts economy, 70 per cent, or $697 million, consists of institutional operating accounts which is 2.9 per cent of the Commonwealth's gross domestic product.

Institutional Purchases

Three out of every four dollars spent by the eight major universities is spent in the metropol.tan Boston area. Out of their total operating expenditures of $697 million, 42 per cent ($282 million) is spent on purchases of supplies, materials and equipment for current operations. Of that $282 million in purchases in 1972, 75 percent ($211 million) was spent in the greater Boston area.

Construction
Since the wave of post war construction started in 1950, through 1972, university construction programs at the eight major universities in the Boston area have contributed more than $647 million to the local economy. More than 55 per cent of this has gone into the Boston Metropolitan area. As of 1972, annual construction outlays by the 65 local colleges and universities was in excess of $120 million per year.

Impact on the Financial Community
Of the $2.1 billion in combined assets in cash and securities held by the eight major universities nearly $2 billion is in metropolitan Boston. Faculty, staffs and students have local bank accounts totaling $224 million. In addition the eight universities are borrowers of $130 million, half of their loans negotiated with Boston area agencies. Gifts from benefactors—a combined $515 million total since 1967—a substantial portion of which comes from out of state, provide an inflow of funds into the Boston area.

Expenditures by Faculty and Staff
The faculties and staffs of the eight major universities (numbering 35,400) have combined salaries of $349 million. Ninety-two per cent of these employees live in the Boston area where they paid $27 million in local property taxes in 1972. Of their disposable income of $239 million they spent $196 million (82 per cent) in the Boston area—$118 million on food and housing alone.

Expenditures by Students
There are 70,000 full-time students in the eight major universities; they reported spending nearly $156 million in the Boston area in 1972. A majority of these students appear to come from outside the Boston area. Assuming that students are typically financed by their parents, this suggests a huge inflow of student spending money into the Boston area.

Expenditures by Campus Visitors
Parents, friends and academic and professional visitors to the eight major universities spend nearly a million visitor-days a year in the Boston area. This influx of visitors accounts for expenditures in excess of $15 million a year for food, accommodations, transportation and other purchases.□

When this picture was made, seven young colleagues—mostly M.I.T. architecture students—were on hand to pose with Sandra Howell (center), Research Associate in Architecture, whose project on housing for the elderly is just a year old at M.I.T. It's an informal group of students and staff brought together by a common concern: to bring about "a formal union of gerontology and architecture," which is another way of saying to help architects understand and respond to the problems of human aging.

Housing for Elderly: What the Tenants Want

Walking up the three flights of stairs to Sandra C. Howell's fourth-floor office in Building 3 can take a bit of energy, and not many of the elderly who are the subject of her research make the effort. No matter. Her studies reach out to the elderly in their homes and neighborhoods. Dr. Howell is described as a "trailblazer in bringing about a formal union of gerontology and architecture."

Somehow, I had always felt that architects learned how to design a building by studying the needs and desires of its future tenants, but Dr. Howell has corrected me. Tenant behavior and needs are frequently given low priority compared with such conventional issues as material cost and land availability, she says. Even designers of buildings specifically constructed for a certain group of people—senior citizens, low-income residents, even "singles"—often fail to take into account their future tenants' behavior patterns.

The result is poor use of space, inappropriate materials and fixtures, wasted opportunity.

Dr. Howell's research at M.I.T. has been advanced by the enthusiasm of a group of young architecture and planning students varying seasonally from five to 15. Though the study of public housing is still at an early stage, the data show that senior citizens like to forgather in areas "where the action is"—near mailboxes and elevators, in laundry rooms and entry foyers. Let designers, then, emphasize these functional areas as lounge space in preference to remote, dispersed community rooms.

And builders should consider special details of cabinetry and hardware, the arrangement of balconies, patios, corridors, and traffic flow, the hazards of steps and ramps, materials, color-coding and schematics like those used in subway stations. A host of details, formerly regarded as picayune, now rank high on the list of necessary considerations in designing for older residents.

Architects and developers, Dr. Howell

says, have been working in the dark for years. Their criteria for residential buildings have seldom been related to the psychological, social, even physical changes which take place in later life. Now Dr. Howell hopes to find ways to evaluate the "performance" of a building in tenants' terms, to give these needs an expression that can be understood by those who design the buildings and apartments in which we will live as we all grow older.

But how did Dr. Howell—she is now Associate Professor of Architecture at M.I.T.—find herself involved in this combination of gerontology and architecture?

Well, from this writer's viewpoint, it was a logical step from a bachelor's degree in philosophy, a master's degree in medical care planning (both from Berkeley) and a Ph.D. in environmental psychology—chronic disease care programs (Washington University in St. Louis). Dr. Howell, formerly at Brandeis University, came to M.I.T. because she saw it as an appropriate environment in which to work with her $573,000 grant from the U.S. Department of Health, Education, and Welfare's Administration on Aging for research on "Design Evaluation—Uses of Elderly Housing."

In the year she's been at M.I.T., Dr. Howell and her staff have concentrated on methods for evaluating users' needs in housing, focussing especially on problems of the elderly user. There are already many sites for senior housing projects under study across the nation, and design behavior ideas are being tested at residential sites in the Boston area and elsewhere. But Dr. Howell and Pamela Dinkel, a landscape architect who is her project director, see the present work as part of a broad study of the built environment in relation to the needs of a wide range of user groups. How about lighting in relation to the needs of a resident with failing eyesight? How about research and development on users' needs by manufacturers of hardware and materials?

Dr. Howell is a strong believer in the idea that as people age they know what's best for themselves, and she has reservations about age-segregated housing. Seventy per cent of the nation's elderly own their own homes, says Dr. Howell, and the first issue on her list of priorities is that "something ought to be done to make those homes more livable."

Two matters especially concern Dr. Howell: "involuntary" relocation and the true level of any person's disability—how well he might function given environmental supports. Already Dr. Howell knows one thing: how important it is for older people to live in familiar surroundings. A 91-year-old woman being moved out of her Fenway apartment after 25 years knew: "If I have to move again, I know it'll be the end," she told the *Boston Globe.—C.S.*

An Award of Merit for Trees and Flowers

Ask any visitor about a first reaction to M.I.T. and you'll probably hear something about buildings and laboratories—surely not about lawns and gardens. But the Massachusetts Horticultural Society sees it differently, and so the Society has given the Institute a Special Award of Merit "for the use of trees and plants around a great university."

Indeed, M.I.T. is a compact university that could easily be no more distinguished than the rising apartment and business complexes that surround it in Cambridge. But the trees and plants throughout the campus set it apart from its surroundings. In the cool shade of Killian Court, the Julie Fassett Garden (West Campus), or the McDermott Court (East Campus)—or even in a little courtyard behind Building 3 reputed to be a favorite refuge of former President Julius A. Stratton, '23—students, faculty, staff, and visitors can find respite from concrete and glass.

M.I.T. was the only urban university among the Massachusetts Horticultural Society's 1973 winners, and is the first entire university campus to receive the Merit Award. In past years, only sections of college and university campuses have

Representatives of the Massachusetts Horticultural Society visited the M.I.T. campus in September, 1973. They liked what they saw, and this Special Award of Merit from the Society—given at its 1974 meeting late in the spring—is the result. Laurance Pickard, Manager of Grounds in Physical Plant, says it's everybody's prize: "A lot of people deserve a pat on the back," he told Tech Talk*—including the gardeners who planted elms and rhododendrons in the Killian Court 50 years ago.*

been recipients—such as a suburban experiment station of the University of Massachusetts in Waltham which won last year.

Who takes care of M.I.T.'s prize-winning flora? Laurence Pickard, as Manager of Grounds at Physical Plant, directs a crew of 22—three gardeners who oversee the care of the plants both within and outside the buildings, and 19 groundspeople each with his or her own area covering the entire campus.

A big crew—with a big job. Especially during the summer of 1974, says Mr. Pickard, when it has been particularly hard to keep the trees, flowers, and grass alive, much less healthy. "You name the disease, and M.I.T. was hit with it," says Mr. Pickard. "Dutch elm disease, Japanese beetles, spider mites, loopers. The grass on Briggs Field almost died due to Japanese beetles; there were so many that when you walked on the Field, your pants from the shins down were covered with them." Why this sudden outbreak of garden pests and diseases? Weather—dry and moderately warm; and the withdrawal of pesticides for environmental reasons.□

Dear Former Board Member:

"It may be early, but we would like to remind you that *The Tech* will be 100 years old on November 16, 1981. . . ."

. . . is the opening of one of two letters which has been sent to every alumnus and alumna who was ever a member of *The Tech,* M.I.T.'s oldest newspaper.

Led by Paul E. Schindler, Jr., '74, Chairman of the Centennial Committee, and John D. Kavazanjian, '72, Fund Drive Chairman, *The Tech* is soliciting funds with which to complete two centennial projects—microfilming every bound volume since *The Tech*'s creation, and indexing all stories from 1941 to 1970. Plans are afoot, too, for a reunion of all *The Tech* staffers—past, present, and future—in 1981, as well as a full-fledged celebration, complete with a lecture series, a fund drive, and some other suggestions, befitting the occasion.

As for the centennial's financial status, *The Tech* still needs $500 to complete microfilming and approximately $10,000 (to be spent mostly on staff labor) to finish the index. As Mr. Kavazanjian points out in his letter, "All donors will have their names permanently displayed in the office. Donors of $100 or more may order a facsimile copy of any issue of the paper. Donors of $500 or more may ask for lifetime subscriptions (which were suspended in 1971 because of costs). Donors of $1,000 or more may ask for both facsimile and subscription—and a 35-mm. copy of all issues of the paper from 1881 to 1973."□

Luce Scholarships Open

M.I.T. will submit four nominees to be considered for Luce Scholarships for young American men and women who want to spend a year of study, work, and travel in East Asia. The purpose is to give potential leaders in a variety of fields a first-hand opportunity to become sensitive to East Asian societies and cultures; it is specifically not designed for students intent on becoming East Asian specialists.

Alumni interested in this opportunity should communicate promptly with Professor Eugene B. Skolnikoff, '49, Director of the Center for International Studies, M.I.T. Room E53-473, telephone (617) 253-3140.□

Home for Executives

More than 900 top executives of America's largest corporations attended M.I.T., and the Institute ranks ninth among American universities in its contributions to this group of leading Americans, according to a Standard and Poor's Corp. survey.

Harvard, claiming 2,536 executives, was first; then came Yale, New York University, Pennsylvania, Princeton, Michigan, Dartmouth, and Cornell. Nearly 51,000 executives of 35,000 corporations were surveyed.□

An Award for the Review

Technology Review reports with pride its receipt in July, 1974, of the Ernest T. Stewart Award (below) of the American Alumni Council, the professional organization of alumni workers in the U.S. and Canada. It is the A.A.C.'s highest award, given annually for "outstanding examples of service rendered . . . to institutions or to the cause of education by organized alumni effort."

Two awards were made in 1974—to *Technology Review* as a project of the Alumni Association of the M.I.T., and to "The Portable Stanford," a monograph series sponsored by the Stanford Alumni Association. A single citation said, "These two pace-setting publications must be considered giants in the field. Yet they are honored by this award not simply for being great publications. Rather, they have been singled out for recognition for their remarkable, indeed unique, sense of mission: to render service not only to their alumni, but others as well, by offering intellectual stimulation of uncompromising quality."

Judges in the annual magazine competition of the American Alumni Council

ranked the *Review* among the "top 13" of all college and university magazines and bestowed upon us two special citations: for our coverage of the energy crisis and for "competent handling of difficult subjects."□

The Gallery

Summer activities at M.I.T. held one thing in common—they all occurred outdoors. —Eileen S. Schaffer, '77, (above left) of Van Nuys, Calif., broke the sex barrier at Physical Plant by working there as a summer groundskeeper.
—Atop the 26-foot-diameter radome on the roof of the Green Building, steeplejack Stanley Stokler (bottom left) carefully refinished its fiberglass skin.
—One of the children from the M.I.T. Day Camp (top right and center) couldn't resist a quick shower on Kresge lawn.
—And on Eastman Court, graduate students and employees spent the noon hour playing the Italian game of Boccie (above).
(Photos: Chris Santos; Rich Williams, from Tech Talk*; and Calvin D. Campbell, from* Tech Talk*)*

People

Consolidating Growth in Urban Studies

Langley C. Keyes, Ph.D.'67, who joined the faculty shortly after receiving his doctorate, is now Head of the Department of Urban Studies and Planning; and Lawrence E. Susskind, Ph.D.'73, Associate Professor who directed the Undergraduate Urban Studies Program, is Assistant Department Head.

Professor Keyes succeeds Lloyd Rodwin, Ford International Professor, who has been Department Head since 1970; Professor Rodwin is on sabbatical leave this year and will return in 1975 to continue as Director of the Institute's Special Program in Urban and Regional Studies.

Dr. Keyes is a specialist in housing and urban development, and he admits that being a Department Head "is not something I've been planning for all my life." So he talks more easily about housing and education than about administration.

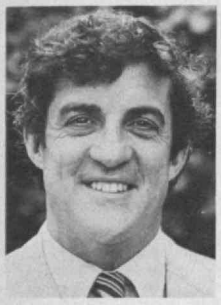
On the former, he supports aspects of the federal urban renewal program and rent control, but he admits that rent control presents sticky administrative problems: how to determine the fair price of an apartment, and how to avoid penalizing concerned landlords who really share their tenants' interests.

On education: the Department is emerging from a period of rapid growth during which "we've accumulated a lot of information and many courses." Now it's time, Dr. Keyes thinks, "to sort through all these ideas and provide a more systematic organization to this intellectual capital."

Dr. Keyes graduated from Harvard in 1960 with a Rhodes Scholarship, under which he studied at Oxford University in politics, philosophy, and economics for two years before coming to M.I.T. eleven years ago. Since then he's been associated with the M.I.T.-Harvard Joint Center for Urban Studies, and he has been Associate Director of Greater Boston Community Development, Inc., since 1971. He has served under the Assistant Secretary for Metropolitan Development in the U.S. Department of Housing and Urban Development and later as Director of Housing Development for the Boston Model Cities Program.

Dr. Susskind is a student of national urban growth and land use policies. He studied at Columbia University (B.A. 1968) before coming to the Institute. Two years after receiving his M.C.P. degree (1970), Professor Susskind was given M.I.T.'s Goodwin Award for outstanding teaching, and he has been associated with the undergraduate program in the Department of Urban Studies and Planning since its inception in 1970.

Professor Susskind is a member of Boston's Metropolitan Area Planning Council and consultant to a variety of federal, state, and local agencies; he is now at work on a study of revenue sharing and the "new federalism" at the M.I.T.-Harvard Joint Center.□



L.C. Keyes

L.E. Susskind

Maggie: Now Get Credit for a Beautiful Machine

"Lecturer in Charge of the Program in Self-Designed Fitness"? *That* title for the author of *Maggie and the Beautiful Machine*?

True. Look in the 1974-75 *M.I.T. General Catalogue.*

Indeed, Margaret B. Lettvin (her husband, of course, is Professor Jerome B. Lettvin, and together they are the Faculty-in-Residence in Bexley Hall) has been giving exercise classes to the M.I.T. community for many years—just as she's been doing for Channel 2 and (through WGBH-TV) on the Public Broadcasting Service network.

But now it's official: Maggie Lettvin is a member of the staff, teaching a class in which students can obtain physical education credit; but it's also, she says, "one of the few classes open to everybody at M.I.T. . . . The classes are for people who need to know about their bodies," and to her that seems to include just about everyone.

"I've always wanted to do a little more," she said, "This will let me spread out a bit," to reach even more people in the M.I.T. community.

Maggie thinks that M.I.T. is "the perfect place for presenting athletics in such a way that people can design an athletic program for themselves and then take it with them.

"How many college athletes do you know who do anything with their skills once they leave college?" she asked.

"The kind of program we have tells them what they are after, and why, and what is most important to them."

This more or less accounts for the description of her program as a "self-designed fitness" activity.

Shouldn't it be "physical fitness?"

"Oh no, not really," Maggie said. "That is a big part of it, of course, but we are really dealing with fitness in a general sense—emotional as well as physical.

"We are trying to make people aware of their needs, what functions they lack—endurance, flexibility, or strength, for example—and what they need to improve in these areas.

"There is no competition in this. There is enough competition—and failure—in life. The idea is just to make your own body better today than it was yesterday.

"We keep talking all the way through class. And we talk freely about the body and its workings."

Maggie makes it clear her classes are for both men and women. She can see why women should not participate with men in contact sports: "The men have more muscle. It's as simple as that. But there is no reason in non-contact sports not to have coed participation."

Exercises and calisthenics are a major part of Maggie's classes, but there is more. "Movement is the key," she said. "We are looking for movement, to enhance the functions the person needs to strengthen."

Away from class, she said, this movement can be achieved any number of ways—through yoga, sports, weightlifting, physical things and the dance, for example. "But," she adds, "none is so well rounded as to take care of all prior conditions. My class does."□

Everybody at M.I.T.—and lots of people all across the U.S.—know Maggie Lettvin as the author and proprietor of "Maggie and the Beautiful Machine." Now Margaret B. Lettvin is officially a member of the M.I.T. Athletic Department staff, and those who complete her course in "self-designed fitness" can have physical education credit. What does Maggie think about that? She doubts it's going to change things very much: "I've been teaching the same thing for nine years," she says. Vice President John M. Wynne, quoted in Tech Talk *when Maggie's appointment was announced, agreed: "The appointment is intended to recognize her contribution and the scope of her program."*

New Faculty: Teachers for M.I.T.'s Future

Appointment of 30 new members of the faculty, including 10 who will hold visiting professorships, was announced during the summer.

—Turner Alfrey, Jr., Senior Research Scientist at Dow Chemical Co., is Visiting Professor of Metallurgy and Materials Science teaching in the field of polymer science and engineering. A graduate of Washington University (S.B. 1938, S.M. 1940) and the Polytechnic Institute of Brooklyn (Ph.D. 1943), Professor Alfrey taught at Brooklyn before joining Dow's Physical Research Laboratory in 1950.

—Elizabeth C. Altman, who has been a part-time teacher in the Department of Humanities, is now Assistant Professor of History. A graduate of Wellesley (B.A. 1949), Ms. Altman completed advanced degrees at Brandeis University (M.A. 1970, Ph.D. 1974).

—Christopher F. Arterton, Assistant Professor of Political Science, expects to receive his doctorate from M.I.T. this year. An instructor at Wellesley last year, he has studied at Trinity College (B.A. 1966) and the American University (M.A. 1968).

—James M. Becker, formerly Lecturer and Assistant Research Engineer at the University of California (Berkeley), is Assistant Professor of Civil Engineering. He holds undergraduate and Master's (1967) degrees from Cornell and the doctorate (Ph.D. 1973) from the University of California.

—Lennart A. E. Carleson, Director of the Mittag-Leffler Institute at the University of Uppsala, Sweden, is Visiting Professor of Mathematics for the current academic year. Dr. Carleson, who was at the Institute on a similar appointment in 1957, holds undergraduate (1947) and doctorate (1950) degrees from Uppsala.

—Peter P.-S. Chen, formerly principal engineer in a computer development project at Honeywell, Inc., is Assistant Professor of Management Science. He came to the U.S. after undergraduate work at the National Taiwan University (1968) and received S.M. (1970) and Ph.D. (1973) degrees in computer science from Harvard.

—James D. Felski, who studied at the Universities of Michigan (B.S. 1971) and California (Berkeley) (S.M. 1972, Ph.D. 1974), is Assistant Professor of Mechanical Engineering.

—Joseph Ferreira, Jr., '67, having been designated for a Class of 1922 Career Development Award, will be Class of 1922 Assistant Professor of Operations Research and Urban Studies for 1974 to 1976. He'll receive special financial support to advance his professional and teaching activities. Dr. Ferreira's undergraduate and Master's (1970) degrees are in electrical engineering; his Ph.D., also from M.I.T. (1971), was in the field of operations research.

—Robert W. Field is Assistant Professor of Chemistry; he came from a similar post at the University of California (Santa Barbara), studied at Amherst College (B.A. 1965) and Harvard (Ph.D. 1972).

—Murray A. Geisler, Director of the Logistics Program at Rand Corp. since 1972, is Visiting Professor of Management Science for the current year; he holds degrees in statistics from the City College of New York (B.A. 1938), Columbia (M.A. 1940), and Stanford (Ph.D. 1962).

—Reuben T. Harris, Jr., formerly Lecturer in the School of Business Administration at the University of California (Berkeley), is Assistant Professor of Organizational Psychology and Management; his degrees are from Antioch College (B.A. 1969), the University of Rochester (M.B.A. 1970), and Stanford (Ph.D. 1974).

—J. Karl Hedrick, Associate Professor of Mechanical Engineering at Arizona State University, is Visiting Associate Professor at M.I.T. A graduate of the University of Michigan (1971), he holds S.M. (1972) and Ph.D. (1974) degrees from the University of California (Berkeley).

—James S. Hekimian, Dean of Business Administration at Northeastern University, is Visiting Professor of Management for the fall term; his degrees are from Harvard: B.A. 1954, M.B.A. 1956, and D.B.A. 1963.

—Ellen J. Henderson, formerly a member of the Research staff of the British Medical Research Council at the University of Edinburgh, is Assistant Professor of Chemistry; she studied at Purdue (B.S. 1966, Ph.D. 1971).

—Stephen J. Kobrin, Teaching Assistant at the University of Michigan, will come to M.I.T. as Assistant Professor of Management upon completion of his doctorate early in 1975; he has previously studied at Rensselaer (B.Mgt.Eng.) and the University of Pennsylvania (M.B.A. 1961).

—Thomas A. Jaeger, Director of the Bundesanstalt fur Materialprufun, Berlin, is Visiting Professor of Nuclear Engineering at M.I.T. this fall. Professor Jaeger was trained as a civil engineer at the Technical University of Berlin, receiving his undergraduate degree in 1956 and his doctorate in 1963.

—James P. Kostman, Assistant Professor of Philosophy, will receive his doctorate later this year from Stanford, where he has been a Teaching Assistant; he holds undergraduate degrees from Princeton (1963) and Oxford (1970).

—James M. Lyneis, '71, who studied electrical engineering and management at M.I.T. (S.B. degrees) and business administration at the University of Michigan (Ph.D. 1974), is Assistant Professor of Management.

—Kenneth R. Manning, a Teaching Fellow at Harvard since 1972, is Assistant Professor of Humanities; his degrees are all from Harvard: B.A. 1970, M.A. 1971, and Ph.D. 1974

—Margaret D. McDuff, since 1972 University Lecturer at the University of York, England, is Visiting Assistant Professor of Mathematics; she has been trained in mathematics at the University of Edinburgh (B.A. 1967) and Cambridge University (Ph.D. 1971).

—Jeffrey A. Meldman, '65, Instructor in Electrical Engineering at M.I.T. for the past four years, is Assistant Professor of Management Science; after completing undergraduate work at M.I.T., Professor Meldman studied at Harvard Law School (L.L.B. 1968) then returned to the Institute for additional work in electrical engineering (S.M. 1970), in which he will receive a doctorate later this year.

—Lorenzo Morris, Instructor in the Department of Political Science since 1972,

has been appointed Assistant Professor; he studied at Fisk University (B.A. 1968) and the University of Chicago (M.A. 1971, Ph.D. 1974).

—**P. Narayan Nayak**, Ph.D.'67, who was a member of the mechanical engineering faculty from 1966 to 1969, returns this fall as Associate Professor of Mechanical Engineering. A native of India, Professor Nayak studied at Bombay University (B.A. 1961) before coming to M.I.T. for graduate work (S.M. 1962, M.E. 1966) and was Assistant Professor of Mechanical Engineering after earning his doctorate (1966 to 1969). Since then Professor Nayak has been Chief of Technical Services in the Research and Development Department at Tata Chemicals, Ltd.

—**Hideo Okamura**, Assistant Professor of Mechanical Engineering at Sophia University, Tokyo, is Visiting Assistant Professor at M.I.T. for the current year; his degrees are from Waseda University, Japan: B.A. 1952, M.S. 1954, Ph.D. 1972.

—**John R. A. Pearson**, Professor of Chemical Engineering at Imperial College, London, is Visiting Professor of Chemical Engineering; it is his second visit to M.I.T.: Professor Pearson was Visiting Lecturer in the spring of 1973. His degrees are from Trinity College (B.A. 1953) in mathematics and mechanical sciences, Harvard (A.M. 1954) in applied mathematics, and Cambridge (Ph.D. 1957) in chemical engineering.

—**Paul A. Sharp**, formerly a member of the research staff at Cold Spring Harbor Laboratory, is Associate Professor of Biology; he will direct work on virus genetics under an American Cancer Society grant to the M.I.T. Center for Cancer Research. Dr. Sharp holds degrees from Union College (B.A. 1966) and the University of Illinois (Ph.D. 1969), and he was a National Institutes of Health postdoctoral fellow at California Institute of Technology from 1969 to 1971.

—**Evgueni N. Sokolov**, Professor of Biological Sciences in the Department of Psychology at Moscow University, has been Visiting Professor of Psychology during the summer; he studied at the Pedagogical Institute in Moscow (1946), the Institute of Philosophy of the Academy of Sciences in Moscow (1950), and the Psychological Institute of the U.S.S.R. Academy of Sciences (1960).

—**Peter H. Stone**, Visiting Professor in the Department since 1972, has been appointed Professor of Meteorology; before coming to the Institute he was Staff Meteorologist at the Goddard Institute for Space Studies of N.A.S.A. and at the same time held Harvard faculty appointments in the field of dynamical meteorology. His degrees are from Harvard (B.A. 1959, Ph.D. 1964).

—**Ezio Tarantelli**, Assistant Professor of Economics and Financial Policy at the University of Rome, is Visiting Assistant Professor of Industrial Relations. A native of Italy, Professor Tarantelli's doctorate is from the University of Rome; he has also studied at Cambridge University, England, and as a graduate student at M.I.T. in 1966.

—**Erik H. Vanmarcke**, Ph.D.'70, Associate Professor of Civil Engineering, is the new holder of the Gilbert W. Winslow Career Development Chair in that Department. The chair recognizes "outstanding accomplishments in teaching and research," and awards are made on a rotating basis; it was established in honor of the late Gilbert W. Winslow ('37). Professor Vanmarcke's work is in the field of structures and structural stability—including the effects of earthquakes and wind loads on buildings and the engineering properties of soils. He studied at the Catholic University of Louvain, Belgium (B.E. 1965), the University of Delaware (M.S. 1967), and M.I.T., where he has been a member of the faculty since 1969.

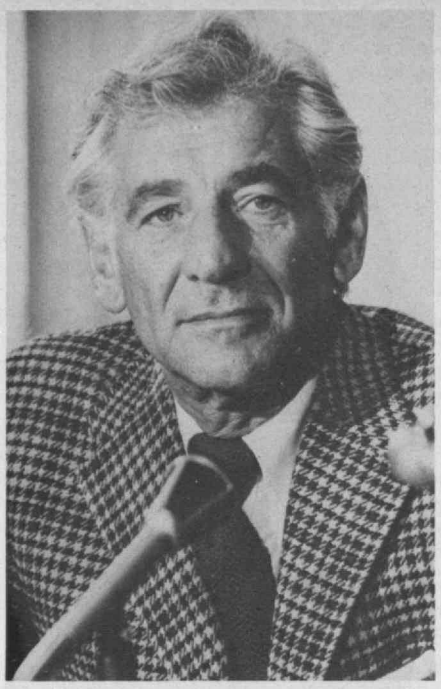
—**Joseph F. Vittek, Jr.**, '62, a member of the staff of the Flight Transportation Laboratory and Lecturer in Aeronautics and Astronautics since 1966, is Assistant Professor of Aeronautics and Astronautics for the current year. Professor Vittek studied at Suffolk Law School and holds the L.L.M. degree from Harvard Law School (1973), and he has been active in organizing a series of summer study programs in flight transportation since 1970.

—**Langdon Winner**, formerly on the faculty at the University of Leiden, Netherlands, is Assistant Professor of Humanities; his degrees are from the University of California (Berkeley): B.A. 1966, M.A. 1967, and Ph.D. 1973.

—**Joel R. Yellin**, Senior Research Associate in the Center for Policy Alternatives and Lecturer in Political Science, is now Associate Professor of Political Science. A specialist in population biology and demography, Professor Yellin was affiliated with the Institute for Advanced Study at Princeton from 1969 until coming to M.I.T. He holds degrees from the California Institute of Technology (B.S. 1962) and the University of Chicago (M.S. 1964, Ph.D. 1966) and has held brief appointments at Princeton, Yeshiva, McGill, and the University of Toronto.□

Leonard Bernstein: Joining Science and Philosophy with Music

Leonard Bernstein, the distinguished American composer, conductor, performer, and teacher, will be Institute Lecturer at M.I.T. during the coming year, participating in a special faculty seminar on the subject of musical structure in relation to aesthetics and linguistics.



Leonard Bernstein

Mr. Bernstein's exploration of the subject began last year when he was Charles Eliot Norton Professor of Poetry at Harvard, and the present appointment is designed to extend the dialogue which began at Harvard. Irving Singer, Professor of Philosophy at M.I.T., thinks the seminar will be the beginning of a new exploration of topics "that relate to the problem of innateness in science and philosophy." It should be, he thinks, a major field for interdisciplinary study at M.I.T. in the future, and he thinks Mr. Bernstein's presence will be "the right impetus at the right moment."

In addition to Professor Singer, regular participants in the seminar with Mr. Bernstein will be David M. Epstein, Professor of Music at M.I.T.; S. J. Keyser, Professor of Linguistics at the University of Massachusetts, Amherst; Ray S. Jackendoff, Associate Professor of Linguistics at Brandeis University; Jerome S. Bamberger, Associate Professor of Music and Education, M.I.T.; George S. Boolos, Associate Professor of Philosophy, M.I.T.; and Alfred W. Lerdahl, Assistant Professor of Music at Harvard. There will be occasional participation by many distinguished linguists, musicians, philosophers, and psychologists from M.I.T. and throughout the Boston area.

Mr. Bernstein is best known for his brilliant tenure as Conductor of the New York Philharmonic and as composer of the mass commissioned for the dedication of the John F. Kennedy Center for the Performing Arts. But he has written a wide variety of works, performed as pianist and conducted opera, and made many contributions to intellectual understanding of music and the arts.□

Sloan Women: "A Logical Step"

Women are taking over the world, you complain? Perhaps; but don't complain. At M.I.T.'s Sloan School of Management it's a welcome change.

Applications by women for the School's Master's program were up 47 per cent in 1973-74, and 25 of the 100 students entering that two-year curriculum this fall are women. Much of the credit goes to Leslie Clift, S.M.'73, Assistant to the Dean at the Sloan School; she wrote personal letters of encouragement to every woman applicant, and she works hard with Dean William F. Pounds and Associate Dean Peter P. Gil to encourage women to pursue professional management training.

But Ms. Clift herself is modest about her role. "What we're seeing is women's perspectives and roles changing," she says. Women are "thinking of themselves differently, viewing their marriages differently."

That point comes into sharpest focus with the School's Sloan Fellowship Program for mid-career executives. Since it began in 1931, only one woman—until this year—has ever been a Sloan Fellow. Now among the 50 1974-75 Sloan Fellows are five women:

—Carolyn S. P. Nanfeldt, Financial Analyst for General Motors Corp., New York.

—Simone Stephens, Assistant to the Executive Officer of the U.S. Public Health Service.

—Maureen A. C. Stefanini, Student Teacher Supervisor at Worcester State College.

—Mary C. Zulalian, Administrator of the Human Ecology Institute, Wellesley, Mass.

—Revathy M. Sriram, Manager of the Computer Department at Binny, Ltd., Madras, India.

Susan Trausch of the *Boston Globe* has sought reactions from husbands of the Sloan Fellows.

Harold Zulalian, who owns a Boston-area Oriental rug business, proposed that he would "study the reading material along with Mary." And he wants to go to the lectures on business which are organized for the wives of Sloan Fellows. "I think it'll be great!" he said. Donald Nanfeldt, Vice President at Lehmann Brothers, a New York investment management firm, thinks it's "a logical step in Carolyn's career." Ms. Nanfeldt has specialized in employee benefits management for 11 years, and she wanted "to broaden my business background and possibly move up into more of a managerial role," she told Ms. Trausch.

Ms. Stephens observed that "Management happens to be a male-dominated field, and women have to learn to deal with that."□

Two unique attributes of the 1974-75 Sloan Fellows in a single picture. Valery I. Tchouprikov, Deputy Head of the Laboratory of Composite Materials at the Baykov Institute of Metallurgy of the Academy of Sciences of the U.S.S.R., is the third Russian to attend the 12-month course for middle managers at M.I.T. And Simone B. Stephens, Assistant to the Executive Officer of the U.S. Public Health Service, is one of five women holding Sloan Fellowships this year (only one woman has ever been a Sloan Fellow before). On the right is Dean William F. Pounds of the Sloan School of Management, who is a more permanent asset for the Fellowship program.

Appointments: 19 Administrative Changes

A chronicle of appointments and changes in the M.I.T. administration during the summer:

—**Annette Anderson** is Assistant Director of the Council for the Arts; she was formerly staff secretary in the Council office, and early this year received the certificate of the Harvard Institute in Arts Administration.

—**Dr. Joseph H. Brenner** is Associate Psychiatrist-in-Chief in the Medical Department, whose staff he joined in 1962 after special training in psychiatry; his earlier medical studies had been in obstetrics and gynecology (Royal College, London) and internal medicine (Liverpool University Medical School). He's written widely of American youth and is founder and Medical Director of the widely acclaimed Cambridgeport Free Medical Clinic.

—**Calvin D. Campbell**, a veteran photographer with 30 years' experience at the *Boston Herald-Traveler* and more recently at Polaroid Corp., is Assistant Director of M.I.T. News Office; he is the author of *Hidden Gardens of Beacon Hill*, and he wrote a column about cameras and photography for the *Herald-Traveler* while a member of the staff there. He succeeds Margo Foote, whose photo-credit line was familiar to *Technology Review* readers.

—**Deborah J. Cohen**, formerly a research assistant for the Career Education Project in Providence and for Boston Mayor Kevin White's Committee on the Urban University, is now Assistant Staff Writer in the Office of Resource Planning.

—**James H. Eacker**, '55, a consultant on academic planning and construction, has been named to a temporary, part-time post in connection with development of the Cambridge property formerly occupied by Simplex Wire and Cable Co. He's working with Kenneth R. Wadleigh, '43, Vice President, and Frederic W. Watriss, '41, Associate Treasurer. Mr. Eacker was Director of the Educational Council from 1960 to 1962 and Administrative Officer of the Department of Mechanical Engineering from 1962 to 1969.

—**Dr. James G. Fox**, formerly Staff Veterinarian at the University of Colorado Medical Center, Denver, is now Institute Veterinarian; he will oversee the care of all animals involved in biomedical research at M.I.T. He studied at the Universities of Oregon and Nevada, Colorado State University, and Stanford.

—**Leslie C. Hruby**, S.M.'73, Assistant to the Dean at the Sloan School of Management, is now also Director of Placement at the School, with new responsibilities in student recruiting and alumni relations.

J. H. Brenner

P. B. Jenney

A. S. Willsky

H. H. Richardson

—Ms. **Michael K. Hubner**, formerly Director of Public Relations at Bentley College, is Assistant Staff Writer in the Office of Resource Planning. She studied at Smith College and Harvard Divinity School and before coming to Boston was associated with the Rowland Co., Inc., public relations, in New York.

—**Dr. Peter B. Jenney**, who joined the Psychiatric Service at M.I.T. on a full-time basis in 1968, is Associate Psychiatrist-in-Chief; he also holds a teaching appointment at Harvard Medical School (McLean Hospital). Dr. Jenny studied at Haverford (where he is now a member of the Corporation), the University of Pennsylvania, and the Massachusetts Mental Health Center, Boston.

—**Donald B. Johnson**, former Director of Development of Cazenovia College, New York, is Assistant Director of the Development Office. He's a graduate of Hamilton College (A.B. 1962) and currently is President of the Central New York College Public Relations Council.

—**Susan C. Knight**, formerly a member of the Analytical Studies and Planning Group in the Office of the President, is Associate Director of the Council for the Arts. Ms. Knight came to M.I.T. in 1969 to be editor in the Publications Office, and she was in the Analytical Studies and Planning Group of the President's Office from 1972 to 1974.

—**Edward Leonard**, formerly Food Service Manager at Illinois State University, Normal, Ill., is now General Manager of Food Services at M.I.T. He assumes duties formerly discharged by Stouffer's Food Services under a contract terminated by the Institute during the summer. Mr. Leonard studied restaurant management at the University of Denver, and his previous experience includes assignments for several commercial, industrial, and institutional food suppliers and services.

—**Kathryn W. Lombardi**, Associate in the Analytical Studies and Planning Group, is now also Manager of Campus Information Services, providing liaison for the Design Services and Registry of Guests. Her first staff assignment at M.I.T. was as Assistant to the Director of the Commission on M.I.T. Education, from 1969 to 1971.

—**Michael F. Luck**, who received his doctorate from Southern Illinois University in June (he was also Special Assistant to the Executive Vice President and Assistant Director of Development there) is now Assistant Director of the M.I.T. Development Office.

—**Patricia M. Maroni**, who graduated from Simmons College in 1973, is Assistant Director of the M.I.T. News Office; she began her writing career at the age of 16 as young people's correspondent and editor of the *Providence Evening Bulletin,* and before coming to the Institute was Assistant Editor of Publications for Stone and Webster Engineering Corp.

—**Mary Morrissey**, whose cheerful smile has been familiar to countless Institute visitors for more than 20 years, has been named Director of the Information Center. She has been on its staff since 1950, and hardly a question can be imagined about the Institute which she hasn't answered in the 24 intervening years.

—**Dr. Wanda S. Needleman** and **Dr. Michael Pearlman**, who are both filling residencies in psychiatry at McLean Hospital, are Clinical Fellows in the M.I.T. Medical Department for the current year. Dr. Needleman studied at Boston University School of Medicine, Dr. Pearlman at Tufts University Medical School.

—**Alan S. Willsky**, '69, Assistant Professor of Electrical Engineering, is Assistant Director of the Electronic Systems Laboratory, where his assignment will focus on research in decision and control sciences. As a senior at M.I.T. Professor Willsky received the de Florez Award for outstanding undergraduate research and the Salisbury Award as the outstanding graduate in the Department of Aeronautics and Astronautics; he joined the faculty in 1973 after receiving his Ph.D. in aeronautics and astronautics.□

A New Head for Mechanical Engineering: Making Engineers' Work Fit Society's Needs

Herbert H. Richardson, '53, formerly Head of its Systems and Design Division, has been named Head of the Mechanical Engineering Department, succeeding Ascher H. Shapiro, '58, Ford Professor of Engineering, who plans to return to teaching and research in biomedical fluid dynamics. Professor Shapiro, an international authority on fluid dynamics, has been Head of the Department since 1965.

In announcing Dr. Richardson's appointment, Alfred A. H. Keil, Dean of the School of Engineering, says Professor Richardson "brings to his new assignment a unique set of capabilities." Especially, he says, he counts on Professor Richardson "to act as a bridge between activities oriented towards engineering science and those oriented towards technical applications."

Professor Richardson will do so. He told *Technology Review* that he has no quarrel with the swing toward increasing emphasis on applications—the Department's growing concern for how the engineering profession fits in with society. He expects "more emphasis on project work dealing with transportation, energy, environment, biomedicine, manufacturing, and production," and he would like to see "more interaction with other departments and interdepartmental groups, inside and outside the classroom." A futurist, Dr. Richardson sees the profession of mechanical engineering playing an even larger role in the years to come in such broad areas as energy conversion and automation.

Professor Richardson came to M.I.T. from Colby College; he joined the staff of M.I.T.'s Dynamic Analysis and Control Laboratory in 1953, completing his Sc.D. degree (1958) while working there.

Professor Richardson became Head of the Systems and Design Division in 1967, and in 1973 he led a major study of the Department's undergraduate curriculum from which emerged proposals for new interfaces with many of M.I.T.'s other schools and departments. Meanwhile, he was on leave from 1970 to 1973 to be the first Chief Scientist of the U.S. Department of Transportation and Advisor to the Secretary of Transportation. While at D.O.T., Dr. Richardson helped to develop procedures which have essentially eliminated aircraft hijacking, for which he was awarded the Secretary's Medal for Distinguished Service.

Professor Richardson also holds the Pi Tau Sigma Gold Medal as the outstanding mechanical engineer of the decade 1953-63 and the 1970 Lewis F. Moody Award (jointly with Professor David N. Wormley, '62) for the outstanding paper in fluids engineering.□

Webster and Green Chairs to Electrical Engineers

Two distinguished professorships in the Department of Electrical Engineering have new tenants:

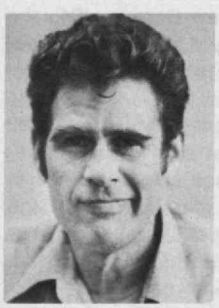
—**Peter Elias**, '44, whose special field is communications theory, is Edwin S. Webster Professor of Electrical Engineering.

—**Richard B. Adler**, '43, recognized for work in semiconductor electronics, electromagnetic theory, and circuit theory, Is Cecil H. Green Professor of Electrical Engineering.

The Green Professorship—Professor Adler's appointment is for a two-year term—was established by Cecil H. Green, '23, especially to help individual members of the faculty move into new areas of research. Its first tenant was Professor Elias, from 1970 to 1972, and its support permitted him to expand his research objectives in communications to encompass the storage and retrieval process of high-speed computers. Now Professor Elias will continue work in this new application of communications theory under the Webster chair; it was established in 1953 to honor the founder of the country's first electrical engineering consulting firm which took the names of two members of the Class of 1888 (Mr. Webster and Charles Stone).

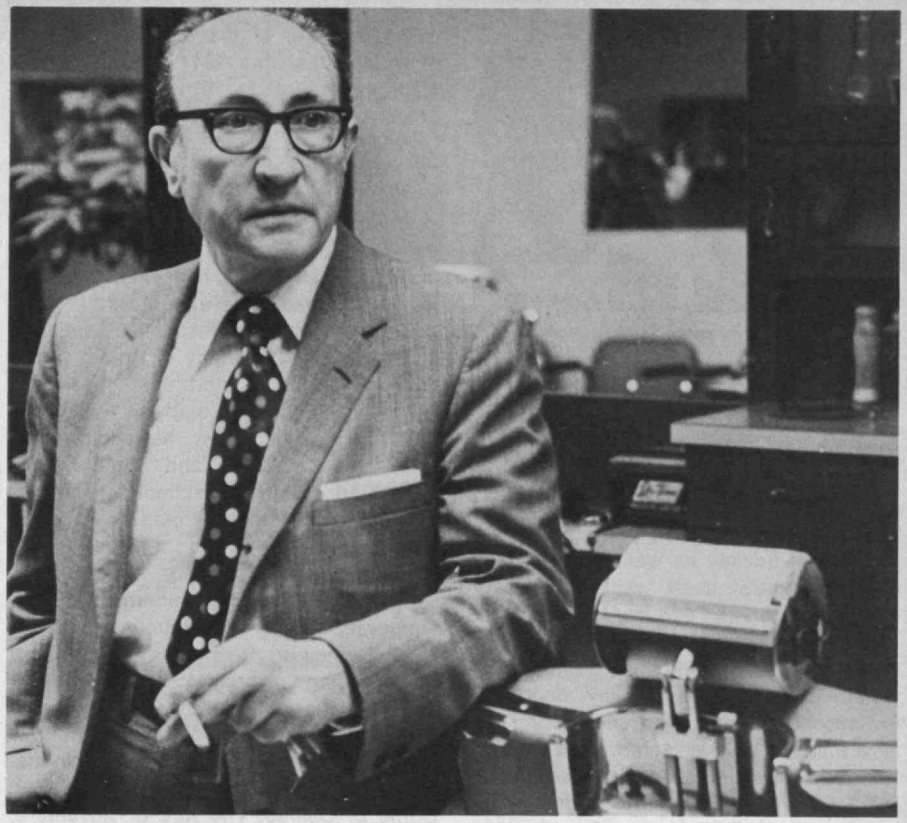
Professor Adler, who is a member of the Energy Conversion and Semiconductor Laboratory in the M.I.T. Center for Materials Science and Engineering, joined the Research Laboratory of Electronics shortly after completing his undergraduate degree at the Institute. He was for two years head of the Solid State and Transistor Group at Lincoln Laboratory, then Technical Director of a Semiconductor Electronics Education Committee developing educational materials, and joined the faculty in 1950 after graduate study at M.I.T. (Sc.D. 1949).

Professor Elias was Head of the Department of Electrical Engineering from 1960 to 1966; his advanced degrees are from Harvard (M.A. 1948, Ph.D. 1950), and he was a member of the Harvard Society of Fellows from 1950 to 1953 before joining the M.I.T. faculty.□



P. Elias

R. B. Adler



A picture may well be worth more than a thousand words when the picture is this one and the word is Cipriano—Lawrence Cipriano, that is, for 44 years proprietor of Larry's Barbershop. Those days are gone now: Larry has retired, along with perhaps 10,000 other Massachusetts barbers (out of 16,000 in 1960). (Photo: Rich Williams)

"I Gotta Do the Best I Can"

If you are a member of the Class of 1930, you may have been one of the first members of the M.I.T. community to have your hair cut by Lawrence Cipriano. But you didn't know him as Cipriano; the name was easier—Larry of Larry's Barbershop.

Lawrence Cipriano started working as a barber at the Tech Coop in September, 1930, at the age of 19; and at that time he could have been mistaken for an undergraduate himself. Seventeen years later, in 1947, Larry screwed up his courage to go into business for himself—first between Walton's Cafeteria and World Tire in a long-demolished business block across from 77 Massachusetts Ave., then briefly in Random Hall, and recently at Technology Square.

Now, 27 more years later, the story has ended. Larry's Barbershop has closed, the victim of hirsute hairstyles and a shortage of help.

In his career, Larry has shorn the heads of many distinguished M.I.T. people—James R. Killian, Jr., '26 (for 44 years), Howard W. Johnson, Chairman of the Corporation, and Albert G. Hill, Vice-President—Research. President Jerome B. Wiesner's first M.I.T. haircut was by Larry, 30 years ago.

What now? A resident of Waltham, Larry still has two more years before he wants to retire; Is he still barbering? No. He's trying a new kind of personal service as a locker room attendant at the Pine Brook Country Club, in Weston. "It's hard to find a job as barber, so I gotta do the best I can, right?"□

Martin: 30 Years of Hockey and Lacrosse

Benjamin R. ("Ben") Martin, Jr., hockey and lacrosse coach at M.I.T. for almost three decades, retired this summer. He was responsible for the growing interest in these sports at M.I.T. and—almost inadvertently—at many other schools; a year ago the New England Hockey Writers Association cited him for the Sheaffer Pen Award for "outstanding contributions to hockey."

Ben Martin will be succeeded as M.I.T. varsity hockey coach by Wayne M. Pecknold, S.M. '65, Associate Professor

B. R. Martin

W. Pecknold

of Civil Engineering, who brings to the job 20 years of experience as player and coach. He wants to emphasize the enjoyment of hockey as well as instruction in the game's basic skills, Professor Pecknold told *The Tech* this fall.

As a member of the Eastern Olympics of Concord, N.H.—in the semi-professional New England Hockey League—Professor Pecknold was chosen for the New England all-star team for the John F. Kennedy Memorial Games in Lake Placid, N.Y., in 1970; he'll coach part-time while continuing to teach in the field of transportation systems analysis.

When Ben Martin began as varsity hockey coach at M.I.T. in 1947, the schedule included such formidable opponents as Harvard, Boston College, Boston University, Northeastern, and the University of New Hampshire—out of our league, now, because of the increasing professionalization of the sport. So over the years Ben Martin has helped encourage other schools to develop hockey and compete with the Institute, and in 1962 he initiated a round robin tournament which proved to be the forerunner of the Division II championships of the Eastern College Athletic Association.

But lacrosse has been Ben's first love since he was an all-American at Syracuse University in the mid-1930s. He's become one of New England's top lacrosse officials, and seven stars of his M.I.T. lacrosse teams have been named all-Americans over the years. In 1958 and 1959 M.I.T. captured the Roy Taylor Trophy, emblematic of the National College Division Lacrosse Championship; and in 1959 Ben was selected as head coach of the North Squad for the annual post-season North-South All-Star Lacrosse Championship.□

Giorgio de Santillana, 1902-1974

Giorgio de Santillana, a distinguished historian and philosopher of science who was a member of the M.I.T. Department of Humanities from 1941 until his retirement as lecturer in 1971, died in Miami on June 8. He was 72.

Professor de Santillana was known to his colleagues as a quiet, scholarly, and highly respected associate, and to his students as a brilliant teacher; death came suddenly while he was enroute from Haiti, where he had spent the winter, to his home in Beverly, Mass.

Born in Rome, Professor de Santillana studied at the University of Rome, where he received his doctorate in physics in 1925. After additional study in Paris concentrating in philosophy, he taught at the Universities of Milan and Rome (where he helped organize a school for the history of science under Professor Federigo Enriques) in Paris, and in Brussels before coming to the U.S. in 1936. He settled at M.I.T. after lectureships and temporary faculty appointments at Harvard, Columbia, Chicago, Stanford, and other leading universities.

During the 1950s and 1960s Professor de Santillana held a number of fellowships which made possible several distinguished books, among them *The Crime of Galileo, The Age of Adventure,* and *The Origins of Scientific Thought.*□

Albert R. Kaufmann, 1912-1974

Albert R. Kaufmann, Sr., Sc.D.'38, who was a member of the M.I.T. teaching staff in the Department of Metallurgy and Materials Science from 1935 to 1962, died on June 7 in Bremen, Maine.

A specialist in the physics of metals, Dr. Kaufmann became a member of the faculty in 1939 and was Associate Professor from 1946 to 1957; he continued as a lecturer until 1962.□

Antoine H. Gaudin 1900-1974

Antoine H. Gaudin, Richards Professor of Mineral Engineering, Emeritus, who was nationally recognized for contributions in process metallurgy, died on August 23 at Massachusetts General Hospital following a long illness. He was 74.

Professor Gaudin, who was born in Turkey, came from a family of distinguished French scientists and engineers, and despite over 50 years in the U.S. he never lost the special warmth and grace which were the heritage of an international French upbringing.

Dr. Gaudin joined the M.I.T. faculty in 1939. He came to the U.S. before World War I when his father, Paul Augustin Gaudin, was assigned to the French War Mission in charge of purchases of railroad materials for use in France. Antoine had earlier studied at the University of Paris, and now his interest in mining, mineralogy, and archaeology led him to study mining engineering at Columbia University. After World War I service in the U.S. Army, Professor Gaudin returned to Columbia for two years as lecturer; then he was at the University of Utah and the Montana School of Mines before coming to the Institute.

Professor Gaudin's early work in mineral engineering was concentrated in flotation, a technique for the separation of minerals on the basis of their specific gravity, and his writing has been the standard in that field since before the first appearance of his book *Flotation* in 1932. By 1945 he was at work on uranium refining for the U.S. atomic bomb project, and in 1957 he received the Robert H. Richards Award of the A.I.M.E. for research leading to the first process for continuous production of uranium from uranium ores. His application of leaching and ion exchange to uranium extraction helped found the U.S. uranium processing industry.

Other fields to which Dr. Gaudin contributed include crushing, screening, and classification of ores; comminution and microscopy of minerals; mineralogical optics; the synthesis of sulfide minerals; hydrometallurgy; and metallurgical applications of radioactive isotopes.

Professor Gaudin was a founding member of the National Academy of Engineering, and he was active in many American and European professional societies. As an Honorary Member of the British Institution of Mining and Metallurgy, he delivered the Sir Julius Wernher Memorial Lecture in 1952, and five years later he was invited to lecture by the Academy of Sciences in Russia.□

Caroline Barrett, 1870-1974

Mrs. Caroline Whitney Barrett, '94, the oldest member of the M.I.T. Alumni Association, died on July 19 in Ipswich, Mass. She was 104.

Mrs. Barrett studied at M.I.T. in 1892 and 1893; she did not hold an M.I.T. degree, and she did not select a field in which to major. But her interest in the Institute remained keen throughout her life—abetted in part, perhaps, by the fact that she was the sister of the late Willis R. Whitney ('90), a noted chemist, educator and inventor who was a member of

G. de Santillana

A.H. Gaudin

the Department of Chemistry from 1890 to his retirement in 1954 and a Life Member of the M.I.T. Corporation beginning in 1938.□

James M. Barker, 1886-1974

James M. Barker, '07, former Chairman of the Allstate Insurance Co. who became a Life Member of the M.I.T. Corporation in 1940, died on July 3 in Chicago after a long illness. At 88, he was the oldest active member of the Corporation.

Howard W. Johnson, Chairman of the Corporation, said Mr. Barker's "wisdom devotion, and benefactions played a major role in the development of M.I.T. . . . His service was a towering example of trusteeship," Mr. Johnson declared.

Mr. Barker's name was given in 1970 to the Engineering Library under the Great Dome of Building 10, reconstructed in that year with resources made possible by his generosity. Though his special enthusiasm was reserved for projects affecting museums, libraries, languages and linguistics, Mr. Barker had "a searching interest in all of the fields represented at M.I.T.", Mr. Johnson said.

Mr. Barker came to the Institute from Pittsfield, Mass., in 1903 to study civil engineering and after completing his studies entered into a career in structural and construction engineering which included seven years teaching at the Institute.

His entry into the financial and management professions came in 1919 when he joined the First National Bank of Boston, of whose branch in Buenos Aires, Argentina, he was manager from 1920 to 1928. He then joined Sears Roebuck and Co. and rose rapidly through a series of appointments to become Director, Vice President, Treasurer and Controller; upon retirement in 1968 he became Chairman of the Sears subsidiary, Allstate Insurance Co.

In addition to his service as a member of the M.I.T. Corporation (he first became a Term Member in 1934), Mr. Barker was a proprietor of the Boston Athenaeum, a Trustee of the Chicago Museum of Science and Industry, a Governing Life Member of the Art Institute of Chicago, and a Life Trustee of Northwestern University and of the Newberry Museum of Chicago. He held honorary degrees from Middlebury (1939) and Westminster (1964) Colleges.

Mr. Barker's services to M.I.T. included membership on a number of visiting committees, a number of Corporation task forces, and the Committee on Financing Development, which conducted the pioneering Mid-Century Campaign from 1949 to 1952. Even in the last months of his life Mr. Barker was carrying on a "spirited" correspondence with various M.I.T. officials on ways of improving the teaching of humanities.□

Individuals Noteworthy

Kudos:
Honors, Awards, and Citations

Honorary degrees to seven members of the M.I.T. faculty in June, 1974: **Jay W. Forrester**, S.M.'45, Germeshausen Professor in the Sloan School of Management, from Notre Dame University . . . **Franco Modigliani**, Institute Professor in the Sloan School of Management, from the Catholic University of Louvain, Belgium . . . **Paul A. Samuelson**, Institute Professor in the Department of Economics, from Gustavus Adolphus College, St. Peter, Minn. . . . **Nevin S. Scrimshaw**, Head of the Department of Nutrition and Food Science, from the University of Rochester School of Medicine . . . **Cyril S. Smith**, Sc.D.'26, Institute Professor, Emeritus, in the Departments of Humanities and of Metallurgy and Materials Science, from the University of Pennsylvania . . . **Victor F. Weisskopf**, Institute Professor, Emeritus, the Department of Physics, from the University of Rochester . . . and **Jerome B. Wiesner**, President, from Harvard (*see July/August, p. 15*) and Notre Dame Universities.

To **Cecil H. Green**, '23, the Human Needs Award of the American Association of Petroleum Geologists . . . to **Richard C. Mulready**, '46, the $10,000 Goddard Award of the American Institute of Aeronautics and Astronautics for "outstanding contributions in the engineering science of propulsion or energy conversion" . . . to **Dino A. Lorenzini**, S.M.'64, the $500 A.I.A.A. Lawrence Sperry Award for an inertial guidance test facility development . . . to **John P. Longwell**, Sc.D.'43, Senior Scientific Adviser for Exxon Research and Engineering Co., the Sir Alfred C. Egerton Medal of the Combustion Institute.

To **Jay W. Forrester**, S.M.'45, Germeshausen Professor in the Sloan School of Management, M.I.T., the Howard N. Potts Gold Medal of the Franklin Institute of Philadelphia, to be presented on October 16 . . . to **Joseph Bordogna**, S.M.'60, Associate Dean of the College of Engineering at the University of Pennsylvania, the $1,500 George Westinghouse Award of the American Society for Engineering Education "for excellence and innovation in the teaching of engineers."

To **Joseph G. Debanne**, Visiting Professor in the Energy Laboratory and Department of Ocean Engineering at M.I.T., a $2,500 prize of the Institute of Management Science for a paper presented at a joint convention of the Institute and the Operations Research Society of America in Boston in June . . . to **Herbert S. Bridge**, Ph.D.'60, Associate Director of the M.I.T. Center for Space Research, the N.A.S.A. Exceptional Scientific Achievement Medal for contributions to the Mariner Venus/Mercury mission . . . to **Timothy L. Johnson**, Sc.D.'72, Assistant Professor of Electrical Engineering at M.I.T., the Donald P. Eckman Award of the 1974 Joint Automatic Control Conference of the American Automatic Control Council for outstanding contributions in the field of automatic control.

To **Carl R. Bohne**, '54, the H. W. Sweatt Engineer-Scientist Award of Honeywell, Inc., for development of a cryogenic interferometer spectrometer . . . to **Stephen P. Loutrel**, '65, and **Nathan H. Cook**, '50, of the M.I.T. Department of Mechanical Engineering, the Blackall Machine Tool and Gage Award of the American Society of Mechanical Engineers for a series of papers on electrochemical machining . . . to **Cyril M. Pierce**, '60, of the U.S.A.F. Aeronautical Systems Division at Wright-Patterson Air Force Base, the Air Force Materials Laboratory award for outstanding scientific and engineering achievement *(see also photo)* . . . to **Arthur F. Gould**, '38, Chairman of the Department of Industrial Engineering at Lehigh University, the University's $3,000 Hillman Award.

Students in the M.I.T. Department of Chemical Engineering chose **James H. Porter**, Sc.D.'63, Associate Professor, for the 1974 outstanding teacher award. . . . **John F. Elliott**, Sc.D.'49, Professor of Metallurgy at M.I.T. is an Honorary Member of the Iron and Steel Institute of Japan. . . . **Michael G. McGrath**, Sc.D.'67, Associate Professor of Chemistry at Holy Cross College, was among Outstanding Educators of America designated by an organization of the same name in June. . . . Two M.I.T. alumni, **Joseph M. Blew III**, B.Arch.'66, and **Donald H. Layton**, '72, were designated George F. Baker Scholars upon receiving Master's degrees from the Harvard Business School in June.

Among new Fellows of the American Academy of Arts and Sciences: **William G. Austen**, '51, Professor of Surgery, Harvard Medical School . . . **David Baltimore**, Professor of Microbiology at M.I.T. . . . **James D. Bjorken**, '56, Professor of Physics, Stanford University . . . **Edgar H. Brown, Jr.**, Ph.D.'54, Professor of Mathematics, Brandeis University . . . **Mildred S. Dresselhaus**, Professor of Electrical Engineering at M.I.T. . . . **Harold J. Hanham**, Dean of the School of Humanities and Social Science at M.I.T. . . . **Harold R. Isaacs**, Professor of Political Science at M.I.T. . . . **John G. Linvill**, '43, Professor of Electrical Engineering, Stanford University . . . **Alan Perlis**, Ph.D.'50, Professor of Computer Science, Yale University . . . **Franklin P. Peterson**, Professor of Mathematics at M.I.T. . . . **Alar Toomre**, '57, Professor of Applied Mathematics at M.I.T.

New Fellows of the American Nuclear Society: **Eric S. Beckjord**, S.M.'56, Director of Uranium Enrichment Operations, Westinghouse Electric Corp. . . . **Eric T. Clarke**, Ph.D.'44, Vice President of Technical Operations, Inc. . . . **Jeffery Lewins**, Ph.D.'59, Warden of Hughes Parry Hall at the University of London . . . **Kalman Shure**, Ph.D.'51, Consultant in Radiation Analysis at the Bettis Atomic Power Laboratory . . . **Weston M. Stacey, Jr.**, Ph.D.'66, Associate Director of the Applied Physics Division at Argonne National Laboratory.

New members of the Institute of Medicine: **Herman N. Eisen**, Professor of Immunology at M.I.T. . . . **Murray Gell-Mann**,

Among Gerald Ford's duties during his brief tenure as Vice President was this greeting to Cyril M. Pierce, '60, who was designated by the Downtown Jaycees of Washington, D.C., as one of the ten outstanding young men in federal service in 1974. Dr. Pierce is Chief of the Metal and Ceramic Synthesis Branch at the Air Force Materials Laboratory, Wright-Patterson Air Force Base, Ohio, and Adjunct Professor at the Eugene F. Kettering Engineering and Science Institute and at the University of Dayton. (Photo: U.S.A.F.)

Ph.D.'51, Professor of Theoretical Physics at California Institute of Technology . . . **Robert L. Sinsheimer**, '41, Chairman of the Division of Biology at California Institute of Technology.

Higher Authority in Government

William C. Schneider, '49, Deputy Associate Administrator for Manned Space Flight, N.A.S.A. . . . **Steven I. Freedman**, '56, Assistant Director of the Office of Coal Research, Department of Interior . . . **Avram Kalisky**, '61, Acting Director of the National Physical Laboratory of Israel, Jerusalem . . . **Edward F. Maguire**, '62, Deputy Commissioner for Coordination, Massachusetts Department of Education . . . **Kent W. Colton**, Ph.D.'72, on leave from the M.I.T. Department of Urban Studies and Planning to be White House Fellow, 1974-75 . . . **Paul Levy**, '72, Assistant to the Director of the Energy Office, state of Massachusetts.

Officers, Directors, and Advisers

Robert C. Seamans, Jr., Sc.D.'51, has been re-elected President of the National Academy of Engineering, and **Robert C. Gunness,** Sc.D.'36, President of the Standard Oil Co. (Indiana), has been elected to the Council, its governing body, where his colleagues include **W. Kenneth Davis**, '40, of Bechtel Power Corp. and **Frederic A. L. Holloway**, Sc.D.'39, of Exxon Corp.

Russell C. Kidder, '53, Manager of Commercial Development in the Specialty Chemical Division of Stauffer Chemical Co., is President-Elect of the Chemical Marketing Research Association and will be its President in 1975-76. . . . **William H. McTigue**, '54, Senior Vice President and Treasurer of Haley and Aldrich, Inc., Cambridge, is President of the Associated Soil and Foundation Engineers, a national association of consulting soil and foundation engineering firms. . . . **Howard R. Webber**, Director of the M.I.T. Press, is President of the Association of American University Presses . . . **Joseph K. Dillard**, S.M.'50, Manager of Advanced Systems Technology at Westinghouse Electric Corp., has been nominated to be Vice President of the Institute of Electrical and Electronics Engineers in 1975. . . . **Michael S. Baram**, Associate Professor of Civil Engineering at M.I.T., is Vice Chairman of the American Bar Association's Environmental Law Committee.

New directors and trustees: **Weston M. Stacey, Jr.**, Ph.D.'66, Associate Director of the Applied Physics Division, Argonne National Laboratory, Director of the American Nuclear Society . . . **Henry A. Morss, Jr.**, Ph.D.'34, Trustee of the Woods Hole Oceanographic Institution . . . **William A. Davis, Jr.**, Associate Professor of Law and Urban Studies at M.I.T., Trustee of Amherst College . . . **Mitchell J. Marcus**, '41, President of Production Systems, Inc., and **Arthur M. Vash**, S.M.'53, President of Phillips Screw Co., members of the Corporation of the Museum of Science, Boston . . . Three new members for the Council for the Arts at M.I.T.: **John E. Burchard**, '23, Dean Emeritus of the School of Humanities and Social Science; **Bates Lowry**, Chairman of the Department of Art, University of Massachusetts; and **Thomas K. Meloy**, '17, President of Meloy Laboratories.

At the National Academy of Sciences/National Academy of Engineering: **Alfred A. H. Keil**, Dean of the School of Engineering, Chairman of the Marine Board (N.A.E.) . . . **Donald A. Schon**, Ford Professor of Urban Studies, member of the Commission on Sociotechnical Systems (N.A.S./N.A.E.) . . . **Robert A. Alberty**, Dean of the School of Science, Chairman of the Commission on Human Resources (N.A.S.) . . . **Michael S. Baram**, Associate Professor of Civil Engineering, and **Murray Eden**, Professor of Electrical Engineering, members of the Advisory Committee on the Biological Effects of Ionizing Radiation (N.A.S.).

Members of the Massachusetts Commission on Nuclear Safety appointed by Governor Francis W. Sargent, '39: **George W. Rathjens**, Professor of Political Science; **David J. Rose**, Ph.D.'50, Professor of Nuclear Engineering; and **James J. Mackenzie**, Visiting Scientist in the M.I.T. Laboratory for Nuclear Science and consultant to the scientific staff at Massachusetts Audubon Society.

Appointments: Moving Up in Academe

O. William Muckenhirn, '37, Acting Dean of the Graduate School, University of Toledo . . . **J. Ross Macdonald**, '44, formerly Vice President for Corporate Research and Development at Texas Instruments, Inc., William Rand Kenan Jr. Professor of Physics, University of North Carolina . . . **George P. Shultz**, Ph.D.'49, formerly Secretary of the Treasury, Professor of Management and Public Policy, Stanford University (also Executive Vice President, Bechtel Corp.) . . . **Jerome B. Cohen**, '54, Chairman of the Department of Materials Science and Frank C. Engelhart Professor of Materials Science, Northwestern University.

Richard L. Van Horn, S.M.'56, Vice President for Business Affairs, Carnegie-Mellon University . . . **Toby N. Carlson**, '58, formerly Senior Research Meteorologist at the National Hurricane Research Laboratory, Associate Professor of Meteorology, Pennsylvania State University . . . **Patrick C. Fischer**, Ph.D.'62, formerly Chairman of Applied Analysis and Computer Science at the University of Waterloo (Canada), Head of the Department of Computer Science, Pennsylvania State University . . . **Leland B. Jackson**, '62, Associate Professor of Electrical Engineering, University of Rhode Island.

Deceased

Caroline Barrett, '94; July 23, 1974
George K. Newbury, '98; March 28, 1974
Milton W. Hogle, '01; May 28, 1972
Ralph Hayden, '04; June 25, 1974*
Leonard W. Cronkhite, '05; July 16, 1974
Alf E. Anderson, '06; August 28, 1971
Kenneth G. Chipman, '07; April 29, 1974
James E. Garratt, '07; June 16, 1974
Phil P. Greenwood, '07; April 26, 1974
George Schobinger, '08; June 12, 1974
Frederic A. Fenger, '09; June 12, 1970*
Oberlin S. Clark, '11; June 20, 1974
Livingston P. Ferris, '11; November 20, 1973
Henry C. Dunbar, '12; April 26, 1974*
Milton Kahn, '12; June 25, 1974*
Antonio S. Romero, '12; November 18, 1973*
Anning S. Hammond, '14; May 20, 1974
Frederick L. Hurlbutt, '14; March 8, 1974
Ray Osborne Delano, '15; August 18, 1974
Edward J. Kingsbury, '15; June 1, 1974
Mark Aronson, '16; August 6, 1974
Vannevar Bush, '16; June 28, 1974
Robert R. Desmond, '16; September 16, 1966
John R. Hunneman, '16; June 16, 1974
Carlton M. Dean, '17; June 29, 1974
Paul F. Dudley, '17; June 9, 1974
Colonel Grafton S. Kennedy, '17; May 18, 1974
Robert F. Grohe, '18, June 4, 1974
De Ross Salisbury, '18, May 7, 1974
Stuart G. Wallace, '18; December, 1972
Edmund C. Adams, '19; May 6, 1974*
Joseph Kaufman, '19; February 22, 1974
Edward H. Bragg, '20; October 26, 1973*
Phil Brown, '20; July 30, 1974*
Harold T. Dennison, '21; May 2, 1974*
Romney J. Mellen, '21; April 30, 1974
Raymond G. Moses, '21; July 16, 1974*
Stephen B. Neiley, '22; November 21, 1972*
George B. Allen, '22; August 13, 1974
Hector Lopez, '22; July 29, 1974
F. J. Roethlisberger, '22; May 17, 1974
Lee D. Warrender, '22; February 26, 1974
Ralph R. Dresel, '23; July 5, 1974
Roger J. Evans, '23; December 28, 1973
William W. Johnson, '23; December 11, 1973*
Harry Rubens, '23; February 28, 1974*
Joseph S. Sherer, Jr., '23; February 17, 1974*
D. M. Creveling, '24; May 18, 1974*
Weston S. Earle, '24; June 20, 1974*
Sargent D. Heath, '24; April 29, 1974*
Lachlan W. MacLean, '24; April 9, 1967*
Daniel H. Mead, '24; September 14, 1973
Dewey Nelson, '24; May 25, 1974*
Felix Stapleton, '24, May 12, 1974*
Walter R. Weeks, '24; August 22, 1974
Edward C. Booth, '25; April 13, 1974*
William W. Northrop, '25; May 12, 1974*
Arthur K. Sun, '25; May 7, 1974*
Samuel A. Bloom, '26; April 4, 1974
Saul Brodsky, '26; April 30, 1974*
Giles E. Hopkins, '26; May 22, 1974
Ralph H. Roberts, '26; January 9, 1973
Edwin W. Southworth, '26; May 27, 1974
Martin Walter, Jr., '26; May 13, 1974*
Willard S. Felch '27; November 10, 1973
Jim Frink, '27; May 4, 1974*
Norman L. Hurd, '27; April 27, 1974*
Ralph M. Evans, '28; January 29, 1974*
Ellis A. Johnson, '28, December 16, 1973
Joseph U. McQuillen, '28; June 22, 1974
Joseph C. Whitcomb, '28; April 14, 1974
Arthur B. Marlow, '29; July 27, 1974
Charles M. Perkins, '29; August 7, 1973
A. J. Eric Smith, '29; August 13, 1974
Arthur C. England, Jr., '30; October 7, 1973
Roy W. Ide, Jr., '30; May 4, 1969*
Earl L. Krall, '30; May 29, 1974*
Leo A. Marihart, '30; November 5, 1973
Hazen Sise, '30; February 17, 1974*
Thomas E. Warren, '30; May 20, 1974
Albert H. Cooper, '31; April 19, 1974
Gordon S. Clark, '32; June 30, 1973
John J. Such, '32; June 29, 1974
Frederick M. Cone, '33; November 18, 1973
John Logan, '33; March 15, 1974*
Mrs. Nina P. Collier, '34; June 17, 1974
H. Montgomery Baker, '35; September 28, 1971
Arthur Croxson, Jr., '35; May 17, 1974
Paul E. Smith, '36; May 7, 1974
George Grimminger, '38; December 17, 1973
Paul W. Shumate, '38; April 29, 1974
Thomas F. Reed, '40; March 31, 1974
Robert L. Brown, '44; April 13, 1974
Thomas Washington, Jr., '46; November 24, 1973
David H. Jenkins, '48; November, 1968
Edward Fitzgerald, '51; July 2, 1974
Clyde R. Joy, '51; July 3, 1974
Jack Magidson, '51; May 14, 1974
George C. Brainard, Jr., '52; February 11, 1974
David Spiro, '56; July 5, 1974
James M. Murray 3d, '57; June 10, 1974
Donald E. Grimes, '58; April 24, 1974
Joseph R. Leto, '59; August 9, 1974
James J. McInnis, '59; May 5, 1974
Clark W. Pearson, '60, April 20, 1974
Gary A. Lukis, '64, June 8, 1973
*Further information in *Class Review*

Class Review

96

A recent phone call to the home of **William D. Coolidge** in Schenectady gave a good report of his health and activities. He was about to leave for a few days at his mountain cabin with his son, Larry, who had come on for the vacation trip from Colorado. Earlier in the summer he had had a long visit from his daughter. Your secretary missed her usual June visit with "Dr. Will" because of retiring from the District of Columbia school system and moving back to Massachusetts. News of classmates or their progeny would be welcome at the address below.—**Clare Driscoll**, Acting Secretary, Cliff Street, Plymouth, Mass. 02360

98

Edward H. Davis. '01, wrote me as follows from Waterbury, Conn.: "I thank you for your kind card and note. The life of my brother, **Alvan L. Davis** was not distinguished, as compared with Tech's more striking alumni, though it was quite adequate to itself, and it did persist to his 99th year. He maintained always a close and affectionate relation with his Faculty friends, Professor Richards and, especially, Lodge. With the latter, he toured our North West. His degree was in Course III, Mining and Metallurgy. He began as assistant superintendent of the Ludlam Steel Co. in Pompton, New Jersey—there marrying the proprietor's sister, Helen. After her death he married, a widow, Lillian (Evans) Strobach of Pittsburgh, where he became Assistant to the Superintendent of the Crucible Steel Company of America. He left that in 1918 to become Steel Specialist at Scovill Mfg. Co.

Retiring from Scovill in the 1940s because of reduced health, he continued in Waterbury for the rest of his life, devoting himself to a rigorous regime in rebuilding his physique. During World War II, using his home as a base, he served as a dollar a year man for the Federal Government. In his latter years, he fitted his house with lathe and drill to do wood craft which became of interest to his friends and of value to some novelty shops. Early a gifted player of Chess (in his teens he was a member of the Boston Chess Club) he became in his final years a devotee of Contract Bridge. Some of his striking End Games were published in the whist column of the New York Tribune. He had willed his body to the Yale Medical School, where it doubtless was useful in the study of geriatrics. Internment, after cremation, is to be in the family lot in the Village Cemetery of Dedham, Massachusetts."

Many thanks to Mr. Davis for sending this informative letter about his brother. Alvan's brief obituary was in '98 Class Notes of the previous issue.—**Mrs. Audrey Jones Jones**, Acting Secretary, P.O. Box, 294 F.P. Station, Springfield, Mass. 01108

04

I attended the 70th anniversary of the class of 1904 on Alumni Day at M.I.T. on June 3. I was the only member of the class present. As I have done in the past I joined Fred Goldthwait and his group at the luncheon where I had the pleasure of meeting his wife and daughter and 3 members of the class of 1905. A group picture was taken of the older members present which you can see in the July issue of the *Technology Review*. My granddaughter was graduating from high-school the same afternoon so I left the luncheon early.

I am sorry to report the passing of our classmate **Ralph Hayden**. Notification was received that he died June 23, 1974.

Eugene H. Russell, Jr. 82 Stevens Rd., Needham, Mass.

05

What a joyous occasion at the No. 1 table on Alumni Day! The Class of 1900 was represented by Stanley Fitch; next was John Nolan, Secretary of 1903; Eugene Russell, Secretary of 1904; then Ruth and me with daughter, Marjorie Richardson, as guest; **Henry Buff**, Course III, with his chauffeur, Mrs. Madeline McDonald; then **Lloyd Buell**, Course III, with his grandson, Ron Lusk, M.I.T. '76; and Joseph Wattles, Secretary of 1908. (*See the picture on page 102 of the July/August issue.*) Since the management never arranges for sufficient seatings at the head table, Mrs. McDonald and Mrs. Richardson very graciously found empty seats at nearby tables and apparently enjoyed their meal with other graybeards. It was a very enjoyable occasion. I rather pitied Gene Russell, because none of his classmates turned out to give him the courage to continue the task of representing his class at a time when a secretary needs cooperation. Henry Buff was his usual loquacious self. He seems happy in his bachelorhood and "goes everywhere" on his own.

In talking with Ron Lusk, '76, I learned that a coed member of the Class of 1977 was leaving the following day to row on a women's crew in a national regatta at Los Angeles.

I had to consult the 1905 Portfolio to find out whether I remembered what Lloyd Buell looked like in 1905. I did, but not having seen him since then, I had to look at his registration card for identification. He seemed quite well preserved and active, since he had come east in May, attended graduation exercises of grandchildren at Cornell and Framingham, Mass., and had travelled to Damariscotta, Maine, by bus. I sure did enjoy talking with him for a bit. He is hereby awarded our No. 1 Traveller.

Since Alumni Day Lloyd wrote me that he was back at home, reliving his visit at M.I.T. on Alumni Day and his several trips around New England. He says, "It was an occasion never to be forgotten and perhaps never to be repeated." He adds, "Your jovial countenance and your magnificent white thatch are in my gallery." Also, "I could have picked Henry Buff out of a crowd." Correct. Henry hasn't changed or grown a bit.

I have a letter from his daughter, Margaret Lusk, stating that since Alumni Day Lloyd has been in the hospital following a car accident, in which he broke a collar bone and suffered cuts and bruises; some pneumonia and other problems followed the shock of the accident, but he is recovering nicely, although still very weak. The letter was undated, and my memory is poor, so I like to assume that Lloyd is up and out again.

The saddest thing I have to report is the death of **Leonard W. Cronkhite, Sr.**, who died shortly after his 90th birthday. I had realized that he had been for some months in the hospital, seriously ill, but such a notice of a very dear friend comes as a terrible shock. While he did not graduate with us (he was Brown 1905), M.I.T. and 1905 in particular seemed to be his major college love. He attended regularly all Alumni Days—also Bernice, whom we considered an '05er. Space prevents giving a complete story of his life and of our admiration for him, but I am quoting from the *Boston Herald Advertiser*: "He was one of the first Americans selected for a Rhodes Scholarship at Oxford, and also did graduate work at Harvard. During World War I he was an adviser to the War Industries Board and a special agent for the Labor Dept. During World War II he entered the field of atomic energy and became

President of the Atomic Instrument Co. of Cambridge. He also was Director of Baird-Atomic, Inc., and Chairman and Director of the Atomium Corp. of Waltham. In addition to his son [Dr. Leonard W. Cronkhite, Jr., head of the Children's Hospital Medical Center], he leaves his wife, Bernice Brown Cronkhite; another son, Bayard M. Cronkhite, and a daughter, Mrs. Wayland M. Minot."

Also in the obituary column I have to report the death of **Arthur T. Balkam** on July 15, 1974. Art also did not graduate but was an ardent '05 man, always attending Alumni Day festivities. Not having seen any notices of his death in the papers, I called and talked with Mrs. Balkam, whom I had never met. She stated that she was nearly blind and living alone.

I stated that I would further interpret a letter (July 5, 1974) from Hazel Wells (wife of **A. Warren Wells**). Apparently Warren did not adjust to the change in altitude and temperature in Florida, so he is now in a nursing home at 246 Spring St., Eureka Springs, Ark., 72632; and Hazel is living nearby. She states that Warren is having fine care and apparently getting along well. . . .

Roy H. Allen reports regularly, "I am very well for a nonagenarian, but find it convenient to use a cane."

Gilbert Tower writes, "I continue the same, very well, except my eyes are failing, everything blurry. I have just written a comprehensive "Town Planning Board Report" (for the Town of Cohasset, Mass.) which you would think is silly, but it is very important to me. You would not agree with some of my conclusions." Gilbert always gives me the history of his children, grandchildren, and other kin, so that I feel I could write a pretty good genealogy of the Tower family.

Bill Spalding, another great correspondent (I have two unanswered letters) writes, "All well here, but I am baking the family bread now—about once a week; nothing weak about the loaf tho, just plain solidified, petrified nutriment. I like the job as it takes me back to the happy days, cooking gold ores in the assay lab, basement of Rogers." In a previous letter he says, "Our travel days are past; we haven't left Norfolk for two years, neither by plane or auto." He urges us to stop at Norfolk on our way south, but his description of his cooking isn't too appealing.

Going through my ever-expanding files, looking for a date, I ran across a picture in the *Boston Herald* of June 14, 1955, which showed a bunch of '05 reunioners, wearing our Daniel Boone fur hats. Remember? Henry Buff, **Bill Spalding**, and I have the only survivors. What a hunt I had for those hats but what a hit we made on our 50th! I still have two in my reunion file.

Herb Bailey, who is now the oldest member of the class (born September 2, 1880) writes, "I had to give up my ceramic hobby several years ago because my hind legs were too wobbly. I have my stamp collection that I have carried on most of my life and now play with it a good deal. I have the three Zeppelin stamps (mint) that I bought 40 years ago; they have proved a good investment." Herb notes a correction: the caption under his picture in the *Review* for March/April (*p. 102)* said he was with his granddaughter. "Quite flattering for a man of my age," writes Herb, but "the baby is one of my four great grandchildren." Congratulations, Herb, I have not even one great-grandchild.

I am glad to report that I am getting back to near normal. The doctor continues to say "wonderful"; and Ruth is continually saying "take your cane," but actually quite a bit of time is taken in hunting for the cane, which I absent-mindedly leave here and there. But life is still wonderful.—**Fred W. Goldthwait**, Secretary, Box 231, Center Sandwich, N.H., 03227

09

The early notice of our 65th Reunion sent by **Art Shaw** and the Secretary went to about 90 members of the Class, and 25 return postcards came back. Of these only eight persons on five cards stated that they would attend—**Chet Dawes**, **Mayo Hersey**, **Ben** and Barbara **Pepper**, **Art** and Betty **Shaw**, and **Laurence Shaw** who attended only the Pops Concert with his granddaughter, Jr Rapp. Margaret (Mrs. John F.) Davis, who regularly attends Alumni Day, this year was touring Spain and Portugal.

In accordance with the reunion notice, some of us were guests at the reception for the Class Secretaries with the *Review* editors in the West Lounge of the Student Center. As stated in the Reunion Notice, at the luncheon in Rockwell Cage the 14 class banners placed across the stage began this year with that of '09, its last appearance. Earlier, on Sunday afternoon, Robert J. Holden, Dean of Student Affairs, conducted the annual Memorial Service in the M.I.T. Chapel for alumni deceased during the past year. The following 1909 alumni were listed on the memorial pamphlet: **John N. Boyce**, **MacHarvey McCrady**, **Herbert H. Palmer**, **Harvey S. Pardee**, **John C. Stevens**, **Harry E. Whitaker**, and **Edward T. Williams**.

We were pleased to receive some news items on the return postcards. **Thomas H. Atherton** (IV) gives his present address as Port Royal Plantation, Hilton Head, S.C. . . . **Phil** and Theora **Chase**, whose 60th wedding anniversary was celebrated last September, had already moved to their summer home and could not make the trip to Alumni Day. . . . **Charles Freed**, who lives in Chestnut Hill, Mass., and who used to attend Alumni Day quite regularly, stated that he was unable to attend. . . . **Bob Glancy**, one of the Course VI veterans, writes from Broomall, Pa.: "Time marches on but man usually slows. I do! I have a license to drive. Actually drove 300 miles in '72, ditto in '73. Probably the same in '74 if I linger that long. Violet and I want to continue here until the end but it will require more physical aid than one can easily find. Although still on our feet, we do suffer from a shortage of energy." Until his retirement Bob was a General Staff Engineer in the Executive Operating Department of the Bell Telephone Company of Pennsylvania. **John Dort** writes from Keene, New Hampshire: "Am in fairly good health but cannot travel far from home. Mrs. Dort and I are making out quite well in our own home." . . . **Keyes Gaynor**, living in Sioux City, Iowa, states: "Still on my own two feet." We were pleased to see **Mayo Hersey**, a regular attendant, who was just out of the hospital after surgery and apparently well recovered. . . . **Robert Latimer** (II) still lives in York, Pa., his student home address. . . . **Florence Luscomb**, who over the years has worked diligently for many progressive causes, writes: "Sorry to miss it. I shall be in New Hampshire planting my vegetable garden. Please give my warmest greetings to my classmates."

It is with regret that we report the deaths of additional classmates. Barbara Pepper has notified us that Jessie Heber Joslin, widow of **Garnet A. Joslin** (III), passed away in August, 1973, at Los Angeles where she had lived since her husband's death in Mexico. Ben and Barbara always stopped and spent a few days with the Joslins on their frequent visits to Mexico where Garnet was a mining engineer.

A short time ago we received a detailed notice from the *Montreal Gazette* of the death of Dr. **MacHarvey McCrady** on October 31, 1973, in his 89th year following a short illness. Until his retirement in 1953 he was Chief of Laboratories with the Quebec Provincial Ministry of Public Health. He was born in South Dakota and received his B.Sc. degree from Beloit College, Wisconsin. He also obtained degrees in Sanitary Engineering from the University of Wisconsin and M.I.T. and became recognized as an outstanding bacteriologist. He published many technical papers, was coauthor of a book, *Water Bacteriology*, and received numerous honors and awards. He is survived by his daughter Helen (Mrs. James A. Stenstrom) his son Donald, ten grandchildren and one great grandchild.

Belatedly we received the obituary of **Frederick A. Fenger** (XIII), who died June 12, 1970. Our records show that he was an Ensign on the U.S.S. *Chester* in 1918. He rose to the rank of Lt. Commander and apparently was a civilian until 1944. At the time of his death he was Town Clerk in Norwell, Mass. . . . We also regret to report the death of **George A. Morrison** who died May 3, 1974, at Mackeyville, Pa.—**Chester L. Dawes**, Secretary, Pierce Hall, Harvard University, Cambridge, Mass. 02138

12

This year there were but three 1912 men present at Alumni Reunion events and your Secretary alone celebrated all of these events on June 2 and 3. **Al Davis** and a guest attended the Buffet and Pops concert and **Fred Busby** joined me at the Class luncheon, although just recuperating from an operation. At the Commencement on May 31, some 1300 seniors and grad students were awarded degrees, including 125 women, a record number. (In 1912 there was but one, Miss **Hattie Haub**, who recently died at the age of 92.)

A series of lectures on automobility was the main subject presented, reviewing opportunities created by the automobile and examining challenges technology poses for society, including development of new fuels. There was also an antique auto parade.

As an invited guest of the Class of 1914, I participated in their 60th Reunion events. Three of us visited Jacob Wirth's restaurant on Eliot St., which all of you remember. In operation since the 1850s there is little visible change except that the sawdust is no longer on the floor. The manager gave us a royal welcome and presented us with booklet giving the history of the famous institu-

In 1947, Jay Pratt and Ray Wilson, on the Entertainment Committee, at the 35th Class of 1912 Reunion at the Mayflower Hotel in Plymouth, Mass.

tion, illustrated with photos.

Mac MacCormack, our oldest classmate, celebrated his 90th birthday last May. I am belatedly sending personal congratulations as well as those of our classmates. Mac is one of our best contributors and still writes a good letter. Last February and March he was laid up with a heart attack but says, "the repairs were satisfactory". The trouble, however, is limiting his favorite gardening work. Although he is having difficulty with his hearing, his spirits have not been affected and he seems to be carrying on most optimistically.

Through Mac I learned that **Jesse Hakes** has been having repeated health difficulties and has made several trips to the hospital during the past year or so. However, he is still supervising his very successful nursery activities and is able to mow his extensive lawn. Last January, however, his wife, Mary, sustained injuries to the pelvis and one ankle when she fell in an auto's path. Although now home, she is still suffering some pain. We send our best wishes and deep sympathy to you both, Mary and Jesse. . . . The article in the June *Review* on my covered bridge hobby inspired letters from **George Brigham** and his wife, Ilmo, to write on the subject in which they are also interested, particularly as they both come from New England ancestors. They are both in reasonably good health and Ilmo's eye operation was successful. . . . A brief note from **Walter Green** of Palm Beach, Fla., says that he is feeling well and happy. Recently, he has given up driving his car but says there is excellent bus service which serves his needs. **Harold Brackett** and his niece, Eleanor Forbes, cancelled their plans this winter for Florida due to gas shortage at the time. This is the first year since his retirement that they have not been South. He wrote from his summer home in Limerick, Maine, that fishing had been poor and also that too much rain had forced him to replant most of the garden.

I have sad news from **Harold Manning** who advises of the sudden death of his wife, Helen. She passed away in her sleep on June 16, 1974. She and Harold were active covered bridge fans and our good friends for many years. Harold has moved from their apartment in Woodbury, Ct. to the nearby Hickory Hill Rest Home on Middle Road Turnpike. I have forwarded the deep sympathy of the Class. . . . **Jim Cook** writes briefly, "All is well with me and the family, "but various parts need lubrication."

Due to the thoughtfulness of Betty Shepard, I have learned of the passing of **Milton Kahn** in Boston on June 25, 1974. Milton had been quite ill for the past ten years. He started his career with The American Writing Paper Co. of Holyoke, Mass. and left in 1917 to become an officer in the Army Chemical Warfare Service. In 1919 he founded the Kahn Paper Co. of Boston which is still run by relatives, and where he spent the rest of his career. Throughout his life, he was most interested in community and philanthropic activities. He was president of the Associated Jewish Philanthropies from 1947 to 1950 and Vice-Chairman of the Boston Community Fund campaign from 1936 to 1948, also serving as secretary of the Jewish Federation Council of Welfare Funds, and directing the New England Region activities and other organizations. He is survived by his wife, a son and two daughters, a brother and two sisters to whom we send our sympathy. . . . Belatedly, we learn of the death of **Antonio Romero** of Santurce, P.R. on November 18, 1973. He spent many years with the Public Service Commission but had been an invalid for the past five years or more. The class sends our sympathy.

Henry C. Dunbar, a special student in Course 2, passed away on April 26, 1974 in Damascus, Va., where he had moved three years ago from Miami, Fla. He was employed for many years with Keyes Weare of Buffalo, N.Y. Survivors include his wife, Ellen, two children and six grandchildren. Our Class sends its sympathy.—**Ray E. Wilson**, Secretary, 304 Park Ave., Swarthmore, Pa. 19081

13

The Alumni Days are now history, and 1913 had a normal attendance consisting of Dr. **Francis A. Achard**, Rosalind R. & **George Philip Capen**, **Burton L. Cushing**, **Warren Glancy**, Jane & **Henry O. Glidden**, **Walter Muther** and his daughter, Sally Lawton, and **Charlotte Sage**. The program was well planned and unique. It was very gratifying to greet our classmates and friends of other classes: Donald Severance, Fred Lehman, John Mattill, Richard Knight, and their wives and members of their staffs. Also, Ray and Mrs. Dinsmore, Charles Chatfield, Bird Duff, all of class 1914. Also Paul Wiemer and William Reynolds, son of the late Charles V. Reynolds, 1912 formerly of Canton, Mass. One of our near neighbors is the niece of Ralph Rankin and she recently had dinner with Ralph's widow, Connie Flood and her sister, Margy Flood, when they were spending a vacation in Maine. Connie remembered many of the "boys" in the class of 1913.

We have received a note from **Halsey Elwell**: "Like last year I am going to spend another four months with my son and his family, Dr. James Halsey Elwell, Lake Plantaganet at Bemidji, Minn., 56601.

We have also received a note from Capt. Harvey Haislip: "**Stanley Parker**, who is not well, has asked me to let you know that he would appreciate a line or two saying that he is having physical difficulties, but is making progress." We sent a "get-well" to Stan and he sends his thanks, saying, "I am now in fairly good shape. I don't walk as briskly as I used to. I use a cane and don't walk as far either. About a year ago I suddenly started to fall apart and had to spend two weeks in our infirmary. In addition I had a cataract operation and now I have only one good eye, which accounts for my poor writing. Aside from those things I am in pretty good shape. I had to give up my car and lawn bowling, both of which I miss very much, but I can't complain. Louise and I have been living here for the past 10 years and have enjoyed it very much. They take very good care of the 300 residents. We don't travel any more, but we took many trips all over the world and have them to look back on and enjoy. My good friend, Captain Haislip also lives here and we play a lot of bridge, but my eyesight bothers me at present, although I hope in time I can correct it. I enjoy the *Review* especially the Class Notes, and I send my best wishes to all my old classmates, especially you and 'Roz'. I am grateful for the fine job you are doing. Many thanks to you both."

We have enjoyed receiving a letter from **Heinie Glidden**, our class president, and we appreciate that Heinie is giving the leadership we need. We quote: "It seemed impossible to accept the appointment to the Alumni Advisory Committee. It would involve driving home from Cambridge at night, which I prefer to avoid if possible; also, as Jane's broken foot has not mended as well as expected, our activities (which require walking) are limited. . . . One day recently, when in plymouth, we dropped in on **Bill** and Ellen **Brewster** and enjoyed reminiscing on M.I.T. days on Boylston Street." . . . Mere words cannot express our feelings when we learned of the death of our friend, Vannevar Bush. . . . We were very much pleased to participate in the honors bestowed on our good friend, Dr. James R. Killian, Jr. We hope that you read the articles in the Review, July/August 1974 (pages 64-73.) Best wishes to you all—**George Philip Capen**, Secretary, Rosalind R. Capen,

Assistant Secretary, Granite Point Rd., Biddeford, Me. 04005

14

Our 60th Reunion began on campus in Cambridge on Saturday, 1 June, with a cocktail party and a dinner at the Stratton Student Center. **Louis Charm**, **Ray Dinsmore**, **Lee Duff**, **Walter Eberhard**, **Russ Trufant**, **Alden Waitt** and I represented the class of 1914. Our dinner guests were Violet Dinsmore, Mrs. Harold C. Pearson, Mr. and Mrs. James N. Phinney, Mr. and Mrs. Richard A. Knight and Ray Wilson, '13. Mrs. Pearson is the widow of Harold E. Lobdell, '17, who was Assistant Dean and Dean of Students, and Editor and, later, Publisher of the Technology Review in the years 1922-1962; Mr. Phinney is on the staff of the Alumni Association and Mr. Knight, '17, is its Secretary. Several classmates who had expected to come were kept away by unexpected obligations or by illness. **Ray Dinsmore** presided at the dinner and asked us each to speak briefly. During his own talk at the dinner, Ray revealed that for some years he's been writing poetry, and he read a poem, "Thoughts of M.I.T.—June 1, 1974" that he had composed for his occasion. Ray's poem appears in the July/August issue, at the top of page 103. As our class news began on that page, you probably read the poem there, and saw the picture beside it of some of us at the dinner.

At the business meeting after dinner, Ray asked for and received approval of the official acts of the officers since their election. He then submitted his resignation as president; it was regretfully accepted. After much good-natured pressure, **Alden Waitt** agreed to accept the presidency and was unanimously elected. Ray was made President Emeritus and assured us that he would contribute any class services within his power. **Leicester Hamilton** was elected Vice-President and was re-elected Treasurer, and I was continued as Secretary and Class Agent. In view of these elections, there seemed to be no further need for an executive committee.

On Sunday morning, after breakfast at the Stratton Center, we had a very interesting bus tour of downtown Boston, and saw the many changes which have taken place there since our student days. Most of us then joined in the activities of Alumni Days that afternoon and evening, and on Monday. The preliminary planning and the final arrangements for the reunion were the work of Miss Katherine L. Atwood, Assistant to Mr. Joseph J. Martori, Director for Alumni Services. She was on hand to welcome us when we arrived and saw that we were properly settled in the rooms provided for us by the Institute in McCormick Hall. My designation as reunion chairman was only formal; the credit for our good time is all hers.

Don Douglas wrote in July that he'd sold his large house and, with his wife, had moved to a smaller one, easier to take care of. His new address appears below.

Kathryn and **Alden Waitt** spent several weeks on Cape Cod during the summer. If his first general letter to the class hasn't reached you by the time you read these notes, you may expect it soon.

Ray MacCart wrote early in August that he's making a good recovery from the broken hip that kept him away from the reunion. He mentioned that the building in Washington where he and I worked as very junior Naval Reserve officers for three years just after World War I has been replaced by a lawn (to my mind, a major improvement).

Earle Turner wrote, also in August, that the necessity of entertaining friends prevented his being with us at the reunion, but he added that he was playing in all the New England senior golf tournaments of the summer, and that he and Louis were about to celebrate their 58th wedding anniversary.

Anning S. Hammond died on 20 May 1974. He was with us in the last three of our undergraduate years and received his degree in Course VI. After service in the Field Artillery in World War I, he lived in Colorado, his home state, for a short time, and then moved to Oregon, where he became a division manager with Crown-Zellerbach Corp. in Portland. In 1955 he went to California, where he lived first in Palo Alto and for the rest of his life in Turlock. Anning was married to Grace A. Toleik in 1918. She survives him, as do two daughters.

Frederick L. Hurlbutt died in Venice, Fla., his winter residence, on 8 March, 1974. He was with us in our first two years and received his degree in Course II. After some years with DuPont in Wilmington, Del., he went with the Patent Scaffolding Co., of Chicago, in 1924, eventually became a vice-president of that company, and retired in 1958. His home was in Winnetka, Ill., where he was a member of the Indian Hill Country Club. In Venice, he belonged to the Mission Valley Golf and Country Club, and he was a member of the Builders Club of Chicago. Fred leaves his wife, the former Margaret Winifred Chater, to whom he was married in 1918; two daughters, Margaret H. Wolf, of Wilmette, Ill., and Barbara Hurlbutt, of Washington, D.C.; and a son, Daniel C. Hurlbutt, of Winnetka.

New address: **Donald W. Douglas**, 14948 Camarosa Dr., Pacific Palisades, Cal. 90272—**Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, Conn. 06119

15

Here beginneth the first column of the new season with the hope that you and your families have enjoyed a healthy and happy summer. I am glad to report that on a visit to **Louis Young** at home he is in good shape, walking around without a cane or walker. A great recovery for Louis. Apologies to you fellows whose names were so unfortunately misspelled in our July-August column—**Larry Bailey**, **John Dalton**, **Horatio Lamson** and **Max Woythaler**. And in June, **Orton Camp** and **Evers Burtner**. To continue the exciting letters that came with class dues, we give you (on the dignified and impressive letter of the American Medical Association) our **Stanley H. Osborn** as listed as a member of the Council on Constitution and By-Laws. How did he ever make that?

A recent issue of *The Inch* published by Texas Eastern Transmission Corp., carried a glowing write up of **John Staub**. "A native Tennessean, Staub always wanted to be an architect and studied at the University of Tennessee and M.I.T. Mr. Staub worked with the architectural firm of H. T. Lindeberg in New York City until World War I when he rushed off to a recruiting center with high hopes of becoming an army flyer. Because of his size (a slight 119 pounds at the time) he was turned down by the army; but as a result of a trip to Washington, plus a persuasive spiel, he became naval aviator No. 263, earning him membership in the "Golden Eagles," a group originally composed of the first 300 aviators in the Naval Flying Service. Mr. Staub was awarded the Navy's highest decoration in World War I—the Navy Cross. Recalled to active duty in World War II, he served as commanding officer of the U.S. Naval Auxiliary Air Station at Manteo, North Carolina, and later at Harvey Point, North Carolina.

"At the end of World War I, Staub had decided to return to Knoxville but his New York employer persuaded him to open a branch office for him in Houston, explaining that Houston was fast becoming a city of opportunity for young architects. So off to Houston he went.

"From that day in 1921, his career skyrocketed, and the names of his clients began to read like the listings in *Who's Who* (in which Staub himself has been listed since 1944). One of Staub's greatest strengths as an architect is the distinction he obtains from refined simplicity and a fine sense of proportion. Although his firm has designed many institutional structures, including the Memorial Museum at the University of Texas in Austin, and the Bayou Club, the Fondren Library at Rice University, and the M.D. Anderson Library at the University of Houston, all in Houston, his penchant is for residences.

"In 1921, Staub was elected to membership in the American Institute of Architects. In 1925 he served as President of the South Texas chapter, and in 1941 was named to the national board of directors for the Gulf States District. At the same time, he was made a Fellow of the A.I.A. and later served as Chairman of the Jury of Fellows, composed of six men from different parts of the country; and as Vice Chancellor of the College of Fellows.

"Retired since 1970, he now lives with Mrs. Staub in a River Oaks home he designed in the style of her native New England. Their three children and 11 grandchildren are all Houston residents."

Ray Stringfield of Los Angeles writes, "With 75 per cent of my pep gone, I am retired. A widowed daughter lives with me. I have three children, 12 grandchildren and two great-grandchildren. I underwent two operations last year. I was organizer and first President of Los Angeles Rubber Group, now the largest in the country, and past President of the Southern California Section of the American Chemical Society, American Institute of Chemical Engineers and American Society for Testing and Materials. Have given over 1000 talks on tires or modern chemistry and taught courses in industrial chemistry and rubber technology at the University of Southern California for 12 years. Nine years with Goodyear as Manager, service laboratories in Akron and Chief Chemist in Los Angeles. Twenty-seven years as President of Fullerton Manufacturing Co., in Fullerton, Calif., and 26 years as Secretary Treasurer, Joints, Inc., in Gardena, Calif. I've nearly got my pep back from my last operation, and if I can tone down the arthritis that is bothering my knees, I may take another trip east, but can't

tell yet. Meanwhile, between the Mystery Guild and the Detective Book Club, there is enough reading to keep my evenings occupied and to keep me from reading the good travel and history books which also keep coming."

Bur Swain of Southern Pines, N.C., "Everything down here is tops except the feeling of the 'sunny South'—it is too cold. I owe Archie Morrison a letter. Don't work too hard on our 60th." . . . **Ercell Teeson**, Southbridge, Mass. writes, "I have been retired 16 years and enjoyed every minute of it. Have done a lot of travelling and am still at it." . . . From **Roger Tiffany**, Winsted, Conn., "I am retired and living in a nursing home. I have three daughters, ten grandchildren and five greatgrandchildren." What a fine family for Roge to have, but a pity he is in a nursing home. . . . After a winter in West Palm Beach, **Jim Tobey** refers to his Rye, N.Y. home as Siberia—ah, me!

Fred Vogel, Veneta, Penn., writes, "I am scared to write anything but I am semi-retired all right and have had prolific children so the grandchildren are pretty many. I am going to try to return on the 60th but when you're in the ninth decade—who knows? . . . A very friendly letter from **Ray Walcott**, Cranford, N.J., reviewed in a touching manner, our long class friendship and our early association at Nobel, Ontario in 1915 and 1916.

Bob Welles, Altameda, Calif., with his winter travelling, leads a comfortable and interesting life, "I'll admit we have slowed up a lot. It just doesn't seem natural to see everybody plugging along at 55 miles per hour after the 75 and 80 that we were used to. But frankly it strikes me as not unpleasant—rather restful.

"I did my best to see Kohoutek, but we were having rains just then and I never caught sight of it. Now I am back to picking oranges and tangerines and passing them out to my friends. I wish you weren't so far away. So far as I can tell now, I'll still be paddling around next year, maybe as far as Cambridge."

Oranges are my favorite fruit, so I wish I did live a little nearer to Bob.

Charlie Williams has been very ill. He wrote that he did not know how serious it was, but it was very painful and he was in the hospital a month. But, he was better when he wrote and is looking forward to our 60th.

As a public-spirited citizen, **Pop Wood** is a real "do gooder." As Director of Civil Defense in Peterborough, N.H., Carl presented American Red Cross Standard and Advanced Cards for Training in first aid to the injured to a number of volunteers who had taken his course. That was on June 11. Then later the local paper had this interesting story on Pop and his work and activities. Keep it up, Pop! "Carl Wood of Windy Row is more than Peterborough's Director of Civil Defense. He is a firm believer in the American Indian, and he communicated that belief to the young volunteer tour guides of the Historical Society on Saturday.

"In a tour and lecture of Indian artifacts in the old Phoenix Mill house, Mr. Wood reflected upon his contact and relationship with the Indians and their heritage. Most of his knowledge centers around the Sioux Indians of South Dakota.

"In reply to why he is so interested and devoted to American Indian affairs, Mr. Wood said that his main reason was 'people around here know little of Indians, and I am upset about the way they are being treated.' What little Indian heritage there is in New Hampshire, it appears to Carl Wood, has been forgotten or ignored. In his mind, it is never too late for a little education." (I had two enjoyable lunches here with Pop while he was in Cambridge on business.)

While wintering in Clearwater (ah, me!) **Max Woythaler** had dinner and spent an evening with Tess Hilton who lives there permanently. Upon his return to the "deep freeze" up here, Max told us about his pleasant visit with Tess and **Archie Morrison** and I phoned her.

Ted Brown died April 17, 1974 in Manchester, Conn. . . . **Ed Walker** died February 7, 1974 in Lake Worth, Fla. At our Fiftieth Reunion he gave us each a gift of his Kozak Auto Dry Wash, which he so successfully manufactured and sold. . . . **Jack Dalton** was recently made an honorary trustee of the New England Baptist Hospital in Boston. He had been active on their board for a long time. Congratulations, Jack! . . . While **Frank Murphy** was visiting his family here, we had an enjoyable lunch together. Despite recent bouts with surgery, he keeps cheerful and active and is in good shape. He lives a comfortable retired life in St. Augustine, Florida. . . . After having spent the summer in the wind, rain and fog in London, away from the heat and humidity of New York, **Mary Plummer Rice** went to Paris to help at the U.S.O. Club there. It's remarkable how she keeps going.

Charles A. Speas, '42, writes a glowing tribute to our **Bill Spencer**, "I have just learned from the Engineering Society of Baltimore that Bill had moved to Richmond. This reminds me of all that the M.I.T. Alumni in Baltimore owe to him for all of the work he has done on behalf of M.I.T. I'm sure that I speak for all engineers in Baltimore, M.I.T., and others, in saying 'thanks' and that we will miss him very much. I doubt that anyone has contributed as much to engineering in Baltimore as he has. We send our thanks and best wishes."

Dinger Doane was visiting old friends in Washington, N.C., and stopped to see the U.S.S. *North Carolina* battleship memorial there. . . . **Stan Osborn** did a stretch in a Hartford hospital for salt poisoning, the result of eating too many potato chips while watching TV. What next? . . . **Dave Hughes** asks about our 75th Reunion in 1990. It seems a long way off but maybe we can make some plans for it.

Philip Brothers Chemicals Inc., gave **Larry Landers** a testimonial lunch to celebrate his 50 years with them. I was delighted to attend and found Larry in good shape after his recent severe heart surgery.

A fine letter from **Charlie Gardner** of Cleveland Heights, warms my heart and is a splendid reward for this hard working Class Secretary. He begins, "I just came across your enclosed envelope which I thought had been on its way to you long ago with my dues. That is absolutely no way to treat a chap who for the many years has been one of the finest secretaries a Class could possibly have. Your devotion, dedication and constant good works in behalf of 1915 have made it the spirited, closely knit and outstanding Class that it is. And that's no baloney!" . . . **Phil Alger** sent me his autobiography, *Tales of Myself and Family*. A brilliant engineer, Phil described the exciting and important work he did for our government in the two World Wars and later for General Electric.

Edward J. Kingsbury died June 1 in Keene, N.H. . . . **Ray Delano** died August 18 in Duxbury, Mass. Ray was a generous and regular supporter of Class and Alumni activities and attended every reunion and class luncheon here. He was with us at our June cocktail party.

At the memorial service for alumni held at the M.I.T. chapel on Alumni Day, June 3, these classmates were listed in the prayers among those who had departed in the past year: Lucius Bigelow, Charles Blackmore, Earl Brown, Ted Brown, Sig Helseth, Peter Hooper, Boots Malone, Hank Marion, Lorin Miller, Louis Mitchell, Ben Neal, Ben Rivers, George Rooney, Bill Tallman, Ed Walker and Charles Ward. May their souls rest in eternal peace.—**Azel W. Mack**, Secretary, 100 Memorial Drive, Cambridge, Mass.

16

Before we start off on the account of our 58th Reunion in June, we must express our deepest regret on the death of our most distinguished classmate, **Van Bush**, who died at his home in Belmont on June 28. We'll not outline his outstanding career as a scientist and educator—or as one who marshalled American Technology for World War II—for this has been well covered elsewhere in the *Review* *(pp. 66-69, July/August).* In spite of his ever-busy schedule, Van was one of our really regular '16 correspondents. Note his letter to us in the July issue. Van will be memorialized in services at M.I.T. this fall.

As for the reunion, in the absence of both your Secretaries on doctor's orders, the report of the annual reunion on June 4 to 6 at Chatham Bars Inn is based primarily on notes taken by our devoted Honorary Member, **Bob O'Brien**, with contributions and suggestions by our ever-going President **Ralph Fletcher** and letters from **Charlie Lawrance** and **John Fairfield**. This year we had a total of 25 compared with last year's 34. Here's the list of those who attended: Beatrice and **Walt Binger**, Hope and **Theron Curtis**, Frances and **Paul Duff**, Gladys and **John Fairfield**, Sibyl and **Ralph Fletcher**, **Barney Gordon**, Gretchen and **John Gore**, **Maury Holland**, Lois and **Charlie Lawrance** and their daughter Leonice Freeman, Dorothy and **Dave Patten**, Freida and **Hy Ullian** and Frieda's brother Myron Silbert, **Nat Warshaw**, and our special young couple Rose and **Bob O'Brien**—our Honorary and right-hand aid to Ralph in our reunion planning. Our special guest at the clambake, Mel Howard, the outstanding photographer, has taken our class picture in each of the last 20 years. Ralph and Bob report that they received responses from approximately 100 of the 164 living members of the class who were contacted. Several mentioned particularly that they hoped to make the 60th in '76. It was just plain beautiful weather during the days of the reunion. Things moved at a leisurely pace and there was the continued wonderful bond of friendship. Charlie Lawrance says, "The reunion was a real success and very happy, although we missed many of the old-time companions of M.I.T. days and other annual get-togethers. . . . The whole

Class of 1916, 58th Reunion, Chatham Bars Inn, Chatham, Cape Cod.

crowd was congenial and friendly, enjoying every moment of varied conversations. It surely reflected the fine attitude of the class officers throughout the past winter in keeping the old M.I.T. spirit going and growing, for which we are forever grateful."

As for the clambake, Charlie reports, "The day was beautiful, clear, and sunny with a gorgeous view over the bay, boats coming and going among the fleet of anchored boats awaiting use by eager boaters. . . . The clambake was delicious and we ate clams, lobsters, wee salads with coffee plus Ralph's Italian wine, in the shelter of the bay. We left early with a spare lobster in a doggy bag to visit with our son Dick, and let him enjoy lobster meat for his supper—he is unfortunately very ill in a nursing home in Plymouth." You all will remember Dick (M.I.T. '40) at our 50th in Oyster Harbors. And John Fairfield noted that at the clambake, "Duff sat opposite Binger, so conversation flowed freely. Paul commented on losing weight, some 20 pounds on each of two illness trials. He showed pictures of a Duff family get-together, a total of 62: ten children, plus appropriate spouses, 39 grandchildren, and one great. Binger was asked how he managed in Persia—whether he had learned Persian. Walt replied No, for all the responsible people he dealt with had studied in the U.S.A., England, France, or Germany. Walt speaks German fluently and French passably; so when a question was stated in Persian, it was repeated in one of his three languages, fielded by Walt, and the answer translated into Persian promptly—no problem." Then at a group get-together on Ralph's veranda there was a lively discussion of domestic and foreign affairs. Among the items noted, for example, were: it appears that we no longer have freedom in the use of private property. The courts have refused to back up the Constitution. The legislative body has been of no help to the property owner. Rent control—zoning . . . for the public good. What's the difference between "public good" and "Communism"? Again: The newspapers and other media have lacked objectivity in their treatment of Watergate and related matters; and the verdict of guilt or innocence unfortunately may not be based on facts but rather on political considerations. John Fairfield noted "We sat in the sun for an hour, soaking up free vitamins, and finally Walt Binger asked me if I were a walker. I assented and we had a good long walk, including Maury Holland part way, along the shore. We both ended with more sunburn than expected for we wore no hats." At the class meeting later on, the Secretary's and Treasurer's reports were read, followed by a brief report on the luncheons (1916-17) in New York City at the Chemists Club, and a special report by the Treasurer on the James M. Evans Memorial Fund. There were suggestions for the disposition of the original red jacket now worn only by M.I.T. graduates who have reached the 50-year status. The original belonged to Jim Evans and was turned over to the Class of 1916 by his granddaughter. It was agreed that we will arrange with M.I.T. for a suitable display and use of this jacket. Finally, plans for the 60th reunion were discussed. At the as-always outstanding banquet, discussion centered on many items relating to 1916. Ralph acknowledged the many classmates who intended to be at the reunion but had to cancel because of physical disability of one sort or another. He noted, "The medical profession conspired to keep us apart." Individual cases were mentioned briefly; and for the case where attendance was not possible because of a bad tooth problem, Ralph said "it looked as though the absentee was bragging about having his own teeth." Paul Duff told some stories as only he can tell them. (He is writing a book on his experiences and observations in medicine). Many wedding anniversaries from the 51st to the 60th were noted plus a generous supply of admitting that birthdays had reached four-score. Walt Binger will be 87 next January and admitted he had made 30 jumps in a Fairfield County Hunt prior to a luncheon in his honor on his 85th birthday. He still does a great deal of riding.

Other little items that came out during the reunion: John Gore has been in Scouting for over 40 years and is a member of the Silver Beaver Committee in his county in New York State. There is now a Barnett Gordon scholarship for mathematics scholars at Lowell Technological Institute in Lowell. Barney as a retiree reads six or seven hours a day and has been active in various fund-raising committees for hospitals, homes for the elderly, etc. Frances and Paul Duff report that son Brian is serving his second term as a state representative in Illinois. Ralph Fletcher has converted Maury Holland to the use of honey and vinegar in the hope that it will help with arthritis as it has helped others. And Dave Patten wrote us later that "Bob O'Brien had everything under control at the reunion, as usual. It was a disappointment to see so few. As always it was good to catch a brief glimpse of Barney Gordon and of course Paul Duff and his wife. The day was windy and on the cool side, but sunny," So there we have the story of the 58th, with a lot of generous help which is much appreciated.

This year, we had no chance to see **Frank Ross** shoot some birdies on the Cape, but he wrote us in July from Naples, Fla.: "Wish I could write you some exciting news but things seem to go along smoothly without much excitement. Still playing golf four or five times a week but my grandson can beat me now so you can see how I've slipped, but I am having fun and that's the main thing."

We regret to report the death of **Dick Hunnemen** at Wellesley Manor. During his business career he was associated with Bemis Bros. Bag Co. in Boston, retiring in 1959. As the *Boston Herald* says: "During World War I he served as a company commander in the 30th Infantry Regiment (Rock of the Marne) of the Third Division. He received the Purple Heart, the Silver Star, and six battle stars for his participation in the battles of Aisne, Champagne, Champagne-Marne, Aisne-Marne, St. Mihiel and Meuse Argonne. In 1961 he was one of the Third Army Division veterans of World War I who made a pilgrimage to Chateau Thiery in France. An avid yachtsman, he was a life member of the Boston Yacht Club and a member of the Corinthian Yacht Club until his recent illness. He leaves two sons, a daughter and

two grandchildren."

The multiple bits of news and letters received during the summer months will all be reported in the December issue. So keep your two would-be hard-working Secretaries busy with bits of news or morsels of philosophy.—**Harold F. Dodge**, Secretary, 96 Briarcliff Rd., Mountain Lakes, N.J. 07046 and **Leonard Stone**, Assistant Secretary, 34-16 85th St., Jackson Heights, N.Y. 11372

17

Phil Cristal is sleeping a bit better; his red jacket has been found and returned. After searching high and low he thought to write to the Northfield Inn to see if it might be there. So it was. Since Phil's eye operation last December he has adjusted to his new glasses and has been able to renew his driver's license.

Tom Meloy has accepted an appointment by President Jerome B. Wiesner to be a member of the Council for the Arts at M.I.T. The preamble of the Council states: "Because technology has historically been as intimately associated with the arts as with the sciences, because the arts have traditionally been an important element of the life of the Institute, and because now as never before students desire to aim their education at broad social and humane ends, it appears desirable to establish at the Massachusetts Institute of Technology a group dedicated to fostering the arts, by the name of the Council for the Arts at M.I.T." Tom is president of Meloy Laboratories and is occupied also in Washington's pioneering Arena Stage.

Sympathy to **Penn Brooks** on the death of his mother on June 7 at the age of 105 years and 8 months. A few years ago a friend remarked to Mrs. Brooks that her age was truly remarkable; to which Mrs. Brooks replied, "Yes, but hardly desirable."

Friends of Smith College—husbands, fathers of Smith girls—and former members of Tech Show may be interested in progress toward resuscitation of Northampton's Academy of Music. Professor (Tubby) Rogers once stood in the lobby as a Smith audience trooped in to see **Phil Cristal** and the rest of the Tech Show cast. He came back in a daze to report to **Bill Hunter** and others that he had never seen so many beautiful girls in one place. And at intermission **Paul Gardner** strolled into the nearby railroad station and heard a woman scream when he—in costume—went into the men's room. The Academy—one of a few municipal theaters in the U.S.—is owned by the city and under a trusteeship set up by the donor in 1892. It has put on a bright new interior, spruced up the lawn and is hoping to attract the kind of audiences it did in the past.

An appreciative letter has come from Arthur Fieldler thanking us for the "beautiful red jacket of the Class of 1917." Our attendance on Alumni Day this year was on the slim side, being **Jack** and Mrs. **Hunter**, **John** and Mrs. **Lunn**, your scribe and Mrs. **Dunning**, Conchita Lobdell, **Jack Wood**, **Stan Lane**, and **Ray Stevens**.

There are new addresses for **Col. Lawrence L. Clayton**, Wesley Manor, A-17, Jacksonville, Fla., 32223, and Capt. **George W. Henerson**, 3170 20th St. No., Arlington, Va. 22201.

Regretfully deaths are noted of **Paul F. Dudley** at Boston on June 9 and **Carlton M. Dean** at Laguna Hills, Calif., on June 29. Paul had conducted a securities advisory business for years. Carlton retired eight years ago from Monsanto Chemical Co., where he was director of Engineering Sales at St. Louis.—**Stanley C. Dunning**, Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard**, Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

18

About a month ago I had a few moments to follow a whim—in this case to visit the M.I.T. Historical Collection. It is located in the rear of one of the older buildings across from the Necco Chocolate factory. After climbing stairs and walking down a not too attractive long hall I found myself in a series of rooms with much memorabilia of M.I.T.—many fine portraits of past presidents and professors and artifacts produced at M.I.T. Imagine my pleasure at suddenly seeing a complete display of telephones showing the development from the crudest model of a century ago to the present—all a collection of our classmate **Carleton Tucker**. Just by a coincidence I received a letter a week later from Louise Tucker stating that Prof. Warren Seamans had visited her last winter and came back to M.I.T. with a dozen phones that had been in the basement long before Carleton's death.

Our genial assistant secretary has been vacationing at Cape Cod. He is getting ready for his teaching duties at Northeast University shortly after Labor Day. Here is a note from him dated June 7: "While dining to-day at the lovely Pillar House in Newton I commented to Gladys that I was sorry I missed the recent M.I.T. Reunion due to a bad leg that I am supposed to favor. A couple at the next table heard my remark and the gentleman came over and introduced himself an **Wingate Rollins** 1918. We had a pleasant chat and he wished to be remembered to you."

We are happy to report a visit from Dorothy Rossman who divides her time between homes in Arizona and Maine. While she was here we had dinner with **Clarence** and Dorothy **Fuller**—most enjoyable occasion for all of us.

Your Secretary has been busy as 1974 Chairman of the M.I.T. Alumni Offices Conference September 13-14. As of this date it promises to be the largest get-together of this group in its history. Among eighteeners attending are **Len Levine**, **Julie Howe**, **John Kilduff**, and Harry Le Vine. . . . Here is a note from **Bill Foster** who cannot be here at this time: "Thank you for your letter of June 25th concerning the Alumni Officers Conference on September 13 and 14. I regret that I will have to miss the centennial of the Alumni Association on those days, since we will just be returning from our summer outing and it would be most difficult to arrange the trip over that weekend. I think that the Conference is a fine idea and I am sorry that I will be unable to be with you. I have returned the postal card with my regrets by separate mail.

"May I also say that I read with much interest your Alumni News on the Class of 1918 in the regular issues of *Technology Review*. It is good to hear about our old classmates. There is not much new in my own activities. I still continue to be busy attempting to promote arms control and disarmament, but now as Chairman of a private outside association called the Arms Control Association, it is disappointing to find the influence of the official organization, The Arms Control and Disarmament Agency, has been sharply reduced under the present executive leadership.

"I still enjoy attending the Board of Visitors meetings of the Center for International Studies which do not happen quite often enough. Best regards and best wishes to you." . . . A short note from **Al Walker** follows: "Was hospitalized 41 days for operation on infected toe and blood clots in leg. Returned home on May 4—still have to use a walker to get around, but can report progress." . . . **Don Goss** pens a line stating he just became a great grampaw—so I'm feeling mighty old—still hanging on. . . . Dick Knight forwarded a letter from **Georgius Gannon** thanking him for some M.I.T. plates he had sent him as a gift. I was indeed impressed with the strength of his handwriting. Any buildings he designs will stand the test of time.

All of which brings to mind a recent visit to the **Sam Chamberlains** in their distinctive and traditional home in Marblehead. Sam is getting along on his restricted program—goes to the office most days—and is writing not one but two books—one on his pencil sketches and the second on old Marblehead.

I am happy to report that Stella Grossman has made good recovery from her recent surgery. We spent a pleasant afternoon visiting with Stella and Al recently.

Going back to Alumni Day in early June—'18 was well represented with Hazel and **Sax Fletcher**, Margaret and **Tom Brosnahan**, Mildred and **Charlie Watt**, Stella and **Al Grossman**, Elizabeth and **Julie Howe**, Selma and **Max Seltzer**, **Peter Strang**, and Elinor and **John Kilduff**. A good get-together was enjoyed by all.

By the time you read these notes you will have had notice of our fifth mini-reunion at Endicott House, October 12. Prof. Harold Edgerton will show us pictures of his under water photography amongst other things. We expect a good turn out of eighteeners.

Reliable correspondent **Mal Baber** writes that Jean and he spent a few weeks enjoying the sun and sea at Hilton Head Island, South Carolina in June. . . . **Henry Lacey** has moved to 11A E Avenue A, Melbourne, Fla. 32901. He reports that the Florida Institute of Technology bought the apartment complex (his home for eight years) and forced his move. The 76 apartments became dormitory space for 250 students or more. Progress for Florida Tech.—Henry the evicted victim.

Tom Brosnahan sent me a copy of an article written by him in the June issue of *Mass Retailing Merchandiser*. The conclusions are contained in the following three paragraphs:

"Many of the variety store chains of twenty years ago are now operating under considerable difficulty. Kress and Newberry, both of which persistently carried excessive inventories, have been absorbed by other companies.

"Grant and McCrory had good increases in sales, but poor showings. Long term debt is a heavy burden on them and interest paid was exceptionally high. Operating ratios

were well above most companies and net income was very low. They continued their regular dividends, but failed to earn them, resulting in a decrease in retained earnings.

"A basic reason for poor or mediocre showings for many retailers is that they have too many stores in downtown locations that operate at a net loss due to extremely high rent and taxes per square foot of selling space and heavy overhead expenses. Sales in downtown stores have decreased due to limited parking space and the more attractive facilities in outlying shopping centers." —**Max Seltzer**, Secretary, 60 Longwood Avenue, Brookline, Mass. 02146; **Leonard Levine**, Assistant Secretary, 519 Washington Street, Brookline, Mass. 02146

19

Our 55th class reunion at Chatham Bars Inn Friday, May 31, to Sunday, June 2. Sunday events, and Alumni Day in Cambridge Monday, June 3, found 22 classmates and 14 wives in attendance. They included **George R. Bond**, **Benjamin H. Bristol**, **Royden L. Burbank**, **Everett F. Doten** and wife, **Edmund J. Flynn** and wife, **Ralph H. Gilbert**, **Maurice R. Goodridge** and wife, **Louis J. Srayson** and wife, **James Holt** and wife, **Arthur C. Kenison**, **Wilfred O. Langille**, and his wife, **Carl L. Svenson** and wife, **Edward G. Moody**, **Philip L. Rhodes**, **John L. Riegel**, **Paul D. Sheeline** and wife, **E. R. Smoley** and wife, **Chester C. Stewart** and wife, **Dean K. Webster** and wife. . . . Message from **Frances Weiskittel** expressed regret due to home responsibilities, with greetings to the 55 year classmates. . . . **Jim Reis** also wired regrets but drank in Los Angeles to a successful 55th. Group photos were taken at Chatham. All pronounced the reunion a great success.

On Sunday, June 2, 1974 at 2:30 P.M. a memorial service was held for M.I.T. Alumni who died from May 1973 to 1974. These included the following 1919 men: **Franklin S. Adams**, **Roderic L. Bent**, **Thomas H. Bott, Jr.**, **John J. Hanson**, **E. Russell Hubbard**, **John W. Meader**, **Canley H. Paulsen**, **Lawrence G. Ropes**, **Edward L. Sache**, **Horace D. White**, **Harry A. Zimmerman**.

News from the Alumni Association announced the death of **Edmund C. Adams** on May 6, 1974 in Beaumont, Texas and the passing of **Joseph Kaufman** on Feb. 22, 1974 in Cherry Chase, Maryland.

The Clarkson College of Technology announced the award of the honorary degree of Doctor of Science to **Benjamin H. Bristol** on May 18, 1974. Ben is retired Chairman of Foxboro Company, as well as former President of Foxboro National Bank, trustee of Worcester Academy and Norwood Hospital Board.—**Eugene R. Smoley**, Secretary, 50 East Road, Delray Beach, Fla.

20

This is my first opportunity to tell you that class attendance at Alumni Day last June was eminently satisfactory. Present were Marie and **Frank Bradley**. Betty and **Al Burke**, Barbara and **Bill Dewey**, Lois and **Harold Siniddy**, and Ruth and **El Wason**. . . . We were especially pleased to welcome Eleanor and **Bob Tirrell** for we hadn't set eyes on Bob for many a year. Bob and his new wife, Wellesley, 1920, now live in Lebanon, New Hampshire. They have been travelling a great deal and enjoying life to the full. Bob hasn't changed a bit. It was good to see them.

A few of our classmates have changed their abode. **Jesse Doyle** has moved from Boston to Dublin, New Hampshire, P.O. Box 94. . . . **Jerome Franck** has left Newton for Framingham, at 109 Hastings Street. . . . **Austin Frey** has left Monterey, California for nearby Pebble Beach, at 4046 Custado Road. . . . Mildred and **Chuck Lawson** have sold their home in New Hampshire and have a new address in the same state. Please advise us of your address, Chuck, or will you be at your winter home in Naples, Fla.?

While in Maine I had the opportunity to talk with **Frank Hint** of Juniper Pt., West Boothbay, on the phone and am happy to report that he sounded chipper and is looking forward to our 55th.

Now comes the bad news. **Harold Dennison** of E. Weymouth, Massachusetts who ran the Dennison airport in Squantum, died last May. . . . **Ed Bragg** of Greenwich, Connecticut died last October. . . . **Phil Brown** of West Hartford died in July. Phil had retired as Director and Vice President of the Hartford Fire Insurance Group with whom he had been active ever since graduation. During his career he managed company business in Canada, Puerto Rico and the Virgin Islands. He was founder and past Secretary and Historian of the West Hartford Old Guard, a member of the board of the Connecticut Genealogy Society and a member of the Connecticut Historical Society. He leaves his wife, Myrtle and a son, Phil, Jr.

Another prominent member of our class was **Andrew Johnson** of 8263 Westmoreland Drive, Sarasota. Andy started out as a civil engineer in the Peoria, Ill. highway system. He then joined the Factory Mutual System in Boston and later the Manufacturers Mutual in Providence where he lived for many years. After his retirement he was instrumental in organizing the Factory Mutual Insurance Company of London and was its first Managing Director. He was a member of the Turlss Head Club and the Bobby Jones Golf Club. He leaves his wife, Mida, a daughter, two sons and fifteen grandchildren. I am indebted to Norrie Abbott for the above information, and to Tom Green, '26, for the information on Phil Brown.

Hope you all had a happy, healthful summer and shall successfully survive the winter so that you may join us for the 55th next June. Do write me of your intention to join us for that significant and important occasion.—**Harold Bugbee**, 21 Everell Road, Winchester, Mass. 01890

21

Quite a number of letters have come in during the summer and perhaps the first one to quote from is **Irving Jakobson**'s report about Alumni Day. Attending from our class were Maida and **Ed Dubé**, Elma and **John Mattson**, **Algot Johnson**, Eleanor and **Don Morse**, **George Chutter**, Helen and **Bob Miller**, Gladys and **Paul Rutherford**, Emma and **Al Lloyd**, Wyn and **Roy Wood**, Onie and **Elliott Adams**, Laura and **Bob Haskel**, and **Irving Jakobson** (21 from 1921). Said Jake, "All hands seemed to be in good health and fine spirits at the luncheon." . . . He also reported that **A. Royal Wood** had consented to be Class Vice President, filling in behind the late **Ted Steffian**, and would also continue as Treasurer. . . . **Don Morse** also agree to be Co-Chairman with **Ed Dubé** for our 55th Reunion.

A postcard from **Helen St. Laurent** written at Center Lovell, Maine told of her spending three weeks there and visiting with Theona and **Al Genaske** at Farrington's Inn on Lake Kezar. Al showed pictures of his and Theona's trip to Australia and New Zealand to guests at the inn and Helen reported it a most interesting travelogue. Helen was shortly leaving for Vinalhaven.

At least two of our classmates traveled abroad this summer and early fall. The **Jim Parsons** went to Norway, North Cape, Copenhagen, Vienna and Zurich, and Helga wrote it was a memorable trip. After returning to the Adirondacks where they spent most of the summer, Jim and Helga toured the wine country of New York State and sampled wines at four of the big wineries—"extremely interesting, informative, and downright good fun." Tasty, also? Rumor has it that they sampled 34 different wines . . . . The **Herb Kaufmanns** were to travel in September to Greece and Venice including a two weeks cruise through the Aegean and the Black Seas. Your Secretary wonders if troubles in Greece and Cyprus affected these plans. . . . Herb reported seeing Claudia and **Josh Crosby** in July just before their summer in Brooklin, Maine.

Alumni Fund envelopes continue to be a good source of class news, much welcomed by your Secretary. **Hilliard Cook** of Raleigh, N.C. wrote that he had just finished painting his house, doing all his own maintenacne, which keeps him busy. Said Hilliard, "I think my back is stronger than my head." Not so—others in our class also have been painting their houses this past year. . . . Commander **Glenn Easton** writes "All is well here! Now have an ocean front home at Satellite Beach, Fla. but go north to our home on China Lake, Me. every summer." . . . **Laurence Buckner** of York, Pa., who with Bob Miller did such a marvellous job taking and assembling pictures for our class montage, is still working half days for a 1200 store retail chain, studying and advising how to conserve energy for lighting, air conditioning, heat, electrical equipment, etc. "Have stopped wasting 200,000,000 KWH so far and that will double before we're through." Wow! Have I lost a decimal somewhere?

John Mattson of Winthrop, Mass. and his wife Elma celebrated their 50th wedding anniversary on August 2 at a party at the Weston Golf Club sponsored by their four children. Emma and **Al Lloyd** attended and reported that John acted as Emcee and was in his usual fine form. Their granddaughter modeled Elma's wedding gown and veil. John practiced law for most of his business career, retiring in 1965 as Chief Title Examiner in the Massachusetts Land Court. He is active musically as a euphonium player and soloist in the Wakefield and Rockport bands, and sings in the church choir. John writes that he is still a shutterbug, presenting many slide travelogues, and hopes to get back to art painting again.

Your secretary took off for a late July vacation at Squam Lake, N.H. stopping the first night at Wakefield, Mass. Maida and **Ed**

Dubé joined us for dinner, following which we caught up on each other's news. Ed still maintains an office in Boston and works part time. . . . He and **Don Morse** are mulling over the pros and cons of shifting our 55th reunion locale from Wentworth-by-the-Sea in Portsmouth, N.H. to on-campus in Cambridge. Right after our 50th reunion we were given to understand that on-campus space for our class would not be available in 1976. The rules have changed, so we can have dormitory space on campus if we wish. Ed would like to get class opinion from those planning to attend, so please write him or your Secretary. . . . At Squam Lake we had the pleasure one day of driving over to Wolfeboro Neck and having a picnic lunch on the shore of Lake Winnipesaukee at **Larcom Randall**'s cottage. He and Katherine were in fine fettle and before the sun came over the yardarm, Larc gave us a ride in his speedboat. The Randalls have a beautiful spot on a semi-secluded cove and Larc says that every good morning before breakfast if he sees no telescopes trained on him, he goes in for a skinny dip.

Another visit with a classmate involved calling on **Oliver Coolidge**, who now lives year round in Center Sandwich and whose house overlooks Squam Lake. Oliver worked for many years at Bell Telephone Laboratories in New York City in the transmission field. Both he and wife are active in civic affairs. She is chairman of Sandwich Home Industries (handicrafts) and Oliver is treasurer. . . . Your Secretary took a few short hikes while on vacation including one to the top of Mt. Morgan. His hiking companion was Howard Baldwin '22' who was in the same family camp where we were staying.

It is our sad duty to report the deaths of three more classmates: Captain **William C. Wade** of St. Petersburg, Fla., **Harold T. Dennison** of Weymouth, Mass. and Brigadier General **Raymond G. Moses** of Sandwich, N.H.

Mrs. Dennison wrote that Denny had hoped to come to our 50th reunion but stayed away because of poor health. Denny was an architect and builder, both residential and commercial, and particularly known as the builder and owner of the Dennison Airport in North Quincy. He died May 2 just two months before they would have celebrated their 50th wedding anniversary. The sympathy of the class goes out to Margaret Dennison and their children.

We have to thank Fred Goldthwait, Secretary of the class of 1905, for sending information about General Moses. He served on the staff of Field Marshall Montgomery during World War II and saw service in France in World War I. Moses was a graduate of West Point and got a B.S. degree in Civil Engineering at M.I.T. in 1921. Fred Goldthwait writes that General Moses was "a very loyal M.I.T. alumnus, gave much of himself to the town of Sandwich, was much loved here and a real gentleman."

A good letter from **Dugald Jackson** tells of Betty's and his vacationing in July at their cottage in Yarmouth, Maine, after a minor detour via Schenectady, N.Y. to leave a small holly tree at the house of his son (Dugald III). Dug writes that after serving two terms on the Board of the Northern Maryland Society for the Aid of Retarded Children—and not eligible for a third elected term—he was asked to accept appointment to continue as an ex-officio Board member. He is still a good engineer—"one of the few who seems to always ask 'why' or 'why not' about all proposals." Dug also serves on the Board of Trustees of an old people's home run by the United Church of Christ in Silver Spring, Md.

Irving Jakobson's cruise on the "Dowsabel" this past summer took him to Cape Cod and Nantucket. Before leaving Oyster Bay he wrote **George Chutter** to ask if George could get some of the '21-ers together for a mini-reunion on July 21st. Reports Jake, "George came through in grand style. He and Marion met the "Dowsabel" at the Hyannis Marina and drove us to **Fred Rowell**'s house in Osterville. Fred and Natalie Rowell were gracious hosts for cocktails and supper." The group included besides the Rowells, Jake and his crew, Lita and **Austin Kirkpatrick**, Ann and **Percy Crocker**, Hazel and **Whitney Wetherell**, Gladys and **Paul Rutherford** and Marion and **George Chutter**. "It was a charming and delightful get-together in a lovely setting out doors, overlooking Fred's garden and the waters of Cotuit Bay. It was the highlight of this year's 'Dowsabel' cruise."—**Sumner Hayward**, Secretary, 224 Richards Road, Ridgewood, N.J. 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Circle, Sarasota, Fla. 33580; **Samuel E. Lunden**, Assistant Secretary, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif.

22

Alumni Day in June was fun and games with back slapping and toasting to good health. The wealth wasn't mentioned because everyone is on social security. Our group was reminded of the joy of past reunions with new plans for the 55th being considered. . . . A report received from President **Parke Appel** is comprehensive: "Our first Tech event after arrival was on Friday evening, May 31, when **Don Carpenter** on behalf of the Class of 1922 entertained at cocktails and dinner at the Faculty Club for past and present Class of 1922 Professors and Career Development Award holders. The affair celebrated the promotion of Margaret L. A. MacVicar to Associate Professor and welcomed Arthur P. Mattuck, Professor of Mathematics, as newly designated Class of 1922 Professor. In attendance were John Wulff, Emeritus; Paul E. Gray, '54, Chancellor; Roy Lamson, retiring 1922 Professor; Walter A. Rosenblith, Provost; Dr. MacVicar; Dr. Mattuck; and Joseph Ferreira, Jr., Assistant Professor of Operations Research and Urban Studies and Planning who is the new holder of the Class of 1922 Career Development Award. Members of our Class included **Don Carpenter**, **Dale Spoor**, Class Agent, and **Parke Appel.**

"Sunday night was the bus trip to Symphony Hall for Arthur Fiedler and the Pops where we enjoyed an evening of music with Fiedler's usual expertise supplemented by considerable accent on the percussion section. The M.I.T. red coat adorned the Maestro as it has on many occasions in Florida and California, Tanglewood and Boston.

"Monday's theme was around the future of fuels and automobiles. The lectures were interesting. The Alumni Day Luncheon, attended by 18 classmates, was jovial and well served. Then more lectures and the outdoor cocktails on the greensward side of Kresge."

At home in Venice, California, Parke found an invitation to a 50th wedding anniversary party in honor of Dorothy and **Whitworth Ferguson** on June 25 at the Park Country Club of Buffalo. To which he replied in three parts: "First, I didn't think you were old enough to have reached that milestone; next, we are honored to be invited and wish we could come; next, we hope for you both much health, happiness and prosperity in the years ahead." . . . Another 50th wedding anniversary party: **Norman** and Mrs. **Greene** of Newtown Square, Pa., in May. The party, in the Buffalo Union League's Lincoln Hall, brought together 267 guests—including Gen. Wallace M. Greene, Jr., former Commandant of the U.S. Marine Corps., who is a cousin of Norman Greene. I understand that **Abb Johnson** attended from Muncie, Eleanor and **Sam Vadner** as well as several brothers in Beta Theta Pi. We have been encouraged by receiving many notes during the summer helpful to your Secretary for Class news. . . . Thank you. From **Roy** and Marian **Stone** a card showing the large Roman Aquaduct in Lisbon, Portugal, indicating they were taking a voyage on the "Doric" stopping at Madeira, Casablanca, Malaga, and Lisbon going on further to England, Scotland, Norway, and Germany—and by now will probably have returned to Tampa. . . . A card from **Jack Starkweather** from Ashburnham, Mass., saying that e and his lady were at Sunset Lake for the four summer months at their summer place right across the lake from Mt. Monadnock. . . . From **H. W. McCurdy**: "Catherine and I have had a very pleasant winter and stayed in Palm Desert for a longer time than ever before. After five months I finally got lonesome for the green trees, the rain and "Blue Peter" (his beautiful ship). We had an extensive engine overhaul this past winter, changing the reduction gears—as they were howling." . . . From **Ray C. Ellis**: "We are busy with the usual trees blown down, painting needed, etc. (at Dark Harbor, Maine). Also busy with plans for the United Nations Association of Sarasota of which I am president for 1974, as well as program chairman in Audubon and Friends of Arts and Sciences. Aline and I are looking forward to our 55th Reunion." . . . **Bunt Spaulding** keeps us posted on his activities at the Spaulding Inn in Whitefield, N.H., through his *Mountain View Road News*. We are hopeful that we may have our 55th Reunion at Bunt's inn; **Dale Spoor** and **Parke Appel** are gradually putting some plans together.

From **John Vaupel**: "Maria and I spent a pleasant weekend with **Ted Elliot** and Louise. Ted has purchased a pedigreed Henry Hinckley sailboat and is "all at sea" over it. Since according to custom the original name is not used by a succeeding owner, we suggested 'Spendthrift—a 35-ft sail will demand much. Louise suggested 'Mistress,' but Ted settled on 'Spearhead.' I call my 10-ft. *yatch* the 'Niente'—the nothing." . . .

Those attending Alumni Day were: **Parke D. Appel**, **C. Yardley Chittick**, **Earl H. Eacker** and Peter, **Warren T. Ferguson**, **Whitworth Ferguson**, **Abbott L. Johnson**, **Julian Lovejoy**, **C. Randy Myer**, **Marjorie Pierce**, **Winthrop Potter**, **Fearing Pratt**, **Luciano**

Preloran, **Dale D. Spoor**, **Roscoe Sherbrooke**, **Hall Baker**, **Ted Miller**, **Karl Wildes**, and **Oscar Horovitz**.

Win Potter has written from Norway about their hiking trip through and over the mountains between Oslo and Bergen. They stayed at DNT Huts which furnished bedding and meals, so that they carried only light backpacks. A lot of snow fields were still in the mountains. During July they took short trips into some of the fjords north of Bergen before returning to Lexington. . . . Our Treasurer, **Everett W. Vilett** of Short Hills, N.J., writes that our Class has a modest bank balance totaling almost $1,500 to meet interim expenses. Ev and Janice spent three weeks in Mexico in March including the M.I.T. Fiesta coupled with a trip to Hawaii and a weekend in Las Vegas. They hope to look up friends in Florida this winter in between their duplicate bridge parties. Ev is active on the Town Recreation Commission and is busier than ever since his retirement. . . . **Bill Elmer** has finished a new book entitled *The Optical Design of Reflectors,* and he is selling Xeroxed copies bound in an attractive stiff cover with good response. Bill finds that he has the only text and handbook on this basic subject and believes it will become a classic in technical libraries all over the world. Bill works just as hard as ever without thinking of retirement. Bill won the class prize for having the youngest child—Ned, now 16—at our 40th Reunion and still uses the big punch bowl.

Donald F. Carpenter has again enjoyed West Chop in Martha's Vineyard. Don continues to give much time to M.I.T. and is concerned regarding publicity for the Class of '22 Professorships. His big birthday party given September 7 deserves congratulations from all classmates. . . . **Francis R. Morgan** proudly announces the arrival of his fourth grandchild, Peter Bernhard Morgan of Boston. . . . **Charles C. Bray** of Western Springs, Illinois, is now relaxing as a senior citizen on social security. . . . **C. Lauren Maltby** of Sierra Madre, Calif., tells of interesting discussions with about 15 Pasadena-area alumni at monthly luncheons at the Pasadena University Club.

We regret to report the death of **R. Fritz Jules Roethlisberger** in Cambridge. He taught, researched, and wrote on how people can work together more effectively in industry. His many books include *Management and the Worker, The Motivation, Productivity and Satisfaction of Workers* and *Man-In-Organization.* He is survived by a daughter, Mrs. Jan Roethlisberger, and four grandchildren.

The sympathy of our class also goes to the family of **Bennett H. Levenson** who retired as a patent attorney in Washington, D.C. He worked for the U.S. Patent Office in the 1930s and established his own patent law practice after that time. . . . We are sorry, too, to record the death of **Kenneth R. Sutherland** of Boston. Ken was a life member of Mt. Carmel Lodge, AF-AM of Lynn and a trustee of the American Association of Advertising Agencies. He is survived by his wife Marjorie, a son, Bruce, of Minnesota and two grandchildren. . . . Our sympathy also goes to the family of **Stephen B. Nelley** of So. Yarmouth, Mass.

Among the reported changes of address: **Haywood P. Cavarly, Jr.** of Daytona Beach, Florida; **Bjarne Colbjornsen** of Helsingborg, Sweden; **John M. Goodnow** of Greenbush, Mass.; **Crawford H. Greenewalt** of Wilmington, Del.; **Russell F. Greenough** of Arlington, Mass.; **Lamonte Griswold** of Sudbury, Mass.; **Frederick J. Guerin** of Lawrence, Mass.; **Herbert C. Ham** of Pittsfield, Mass.; **Larrabee D. Hand** of Pelham, Ga.; Rear Adm. **Lloyd Harrison** of Chevy Chase, Md.; **Alan W. Hastings** of Beaumont, Texas; **John F. Hennessy** of Chestnut Hill, Mass.; **Herbert A. Hickey** of Portage, Mich.; **Frederick A. Higgins** of Andover, Mass.; **Robert D. Hoffman** of New York, N.Y.; **George S. Holderness** of Bronxville, N.Y.; **William E. Huger** of Atlanta, Ga.; **William L. Hyland** of Norwood, Mass.; **Roger O. Ingalls** of Dobbs Ferry, N.Y.; **Wyatt H. Ingram** of New York, N.Y.; **Abbott L. Johnson** of Muncie, Ind.; **Anders V. Johnson** of Malden, Mass.; Dr. **Paul S. Johnson** of Bethesda, Md.; and **W. Barton Jones** of Pasadena, Calif. . . . Golfing weather is still marvelous in Buffalo as I hope it is with all others trying to break 90. Lots of luck! . . .—**Whitworth Ferguson**, Secretary, 333 Ellicott Street, Buffalo, N.Y., 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

23

The following attended Alumni Day events at the Institute last June: Horatio Bond, Miles N. Clair, Arthur W. Davenport (Class Historian), Richard Frazier, Herbert Hayden, Howard Lockhart, Elliott Knight, V.P. Bertrand McKittrick, V.P. Royal and Mary Sterling, Julius Stratton, and Dorothy W. Weeks. Among other events was the Memorial Service in the M.I.T. Chapel for alumni who had passed away during the period May 1973-May 1974. Memorialized for our Class of 1923 were: Norman T. Allen, Kenneth S. Andem, Girard Boyce, Robert S. Coupland, Jr., E. Louis Greenblatt, Dr. Robert L. Hershey, David Kaufman, Emil C. Linn, Stephen B. Metcalfe, John H. Neher, Hugh Perrin, William A. Rhodes, Percival S. Rice, Captain Floyd A. Tusler, Georg Vedeler, Philip S. Wadsworth, Michael F. Yarotsky and Colonel H, H. Zornig. Minister for the service was Robert J. Holden, Associate Dean for Student Affairs and Organist was John Cook, Institute Organist. Since then we have received notice of the deaths of **William W. Johnson** of Houston, Texas on December 11, 1973 and **Joseph S. Sherer, Jr.**, of Grosse Pointe, Michigan on February 17, 1974. We quote from Davenport's *Great History of the Class of 1923* as follows: "Johnson, William Walton—Corporation Operations Official, born 1895 in Armstrong, Mo. Prepared at Pritchett Junior College and received his S.B. degree in chemical engineering from M.I.T. . . . His entire career for thirty-seven and a half years was with Sinclair Oil Co., as Superintendent of Refining Operations. During World War I, served in France with the U.S. 26th Engineers." He is survived by his wife the former Marilyn Henderson of Norwich, Ct. And for Sherer: "Sherer, Joseph Stolp, Jr., Corporation Executive, born in 1900 in Aurora, Ill. Prepared at the U.S. Naval Academy and received his S.B. in engineering administration at M.I.T. He became Vice President of Reo Motors, Inc., Lansing, Mich. He was a member of Committee on Financing and Development of M.I.T. 1949."

The Great History of the Class of 1923 is still available from **Arthur W. Davenport**, P.O. Box 574, Virginia Beach, Va. 23451.

Herbert C. Button reports, "Had cataract operation on November 27, 1973, followed by operation to replace detached retina. Hope to be fitted with contact lens in month or two. Cataract in right eye to be removed soon." Hope you have been able to undergo some of the new techniques used to solve problems of this type, Herb! . . . **Elliott P. Knight** tells us "Ethel and I have recovered from our 50th of 1973. There are few instances of a better planned or attended reunion in my memory. Let's have one in 1978! I agree, Elliot, but let's enlist another committee—I'll be glad to serve, but let's have a new warm body to handle the money end! Any volunteers?

Ed Miller writes, "Still working toward the establishment of Rochester Furniture Crafts Guild, Inc., as a key objective for a self-sustaining facility for basic spiritual education so needed in the operation of law, order, and power at home and abroad!"

In the June 1974 class notes we reported the death of **Harry S. Rubens** of St. Petersburg, Fla. Again from *A Great History* we find: "Rubens, Harry Schumann, Instrument Manufacturing Executive, born in 1902 in New York City. Prepared at Erasmus High School and received his degree in chemical engineering practice. Married Veronica L. Ruecker of New York City. He was employed for brief periods with Prest-O-Lite Co., the Barrett Co., and Anaconda Copper Co.; then became engaged in the manufacture of medical apparatus and organized a small firm to make and sell electrical medical specialties merging with American Cystoscope Makers, Inc., in 1931 when he became Division Manager.

"During World War II he began producing optical aircraft gunsights and torpedo directors for the U.S. Navy. After the war he returned to the medical field as Vice President of National Electric Instrument Co., Inc., branching out (after take over by Engelhard Industries) to production of microwave transmitter and modulator cavities for long distance phone communications, retiring in 1965."

Miles Pennybacker tells us of his marriage on February 17, 1974 to Jean Rodney Kintner. Jean, according to Miles' message to us via the Alumni Association pipeline, attended our 50th Reunion last year. Delighted to hear of your happy occasion. Miles goes on to tell of skiing at Gstaad and taking a geriatric treatment from a Dr. Aslan in Bucharest, Romania and feeling really great as ever. Come and see us, Miles, we are not too far from you in Southbury. . . . **Howard F. Russell** again mentions the Order of Daedalians to which he has been recently honored as charter member of Thunderbird Flight 33 of Phoenix, Ariz., and also elected Flight Historian of the Silver Wings of World War I. Howard also informs us that he is a charter member of the Rotary Club of Sun City, Ariz. . . . **Orr N. Stewart** writes, "Still working 50 hours a week keeping our Republicans productive." This intrigues me Orr. What kind of production?

Finally we are glad to hear from **Herb Hayden**, as follows:"Our children gave us a real nice 50th wedding anniversary party in the middle of June. It was a private family group and held at our country club in Fitchburg. Members of our family and their chil-

dren were here from St. Petersburg, Fl., Memphis, Te., Rockville, Md., Montclair, N.J., and Middlebury, Vt. I am improving gradually and getting around a little." To our veteran Class Officer and Reunion Chairman, Best Wishes, indeed!—**Thomas E. Rounds**, Secretary-Treasurer, 990 A Heritage Village, Southbury, Ct., 06488

24

"O suns and skies and clouds of June, And flowers of June together, Ye cannot rival for one hour, October's bright blue weather"—Helen Hunt Jackson. And so, may these notes recall our joyful Fiftieth Reunion at Plymouth and Cambridge, fortunately partly recorded in colored movies by your Scribe A. None of the actors was camera-shy and so all appeared at some time: Ethel and **Russ Ambach**, Hortensia and **Mike Amezaga**, Lila and **Andy Anderson**, Constance and **Fred Ashworth**, **Kay Atherton**, Frances and **Walter Bagby**, "Jocky" and **Phil Bates**, Velma and **Gordon Billard**, Martha and **Roland Black**, Hazel and **Bill Blaisdell**, Besse and **Phil Blanchard**, Esther and **Alec Bone**, Nina and **Web Brockelman**, **Ted Burkholder**, Lorene and **Paul Cardinal**, Allora and **Clint Conway**, Helene and **Austin Cooley**, Luisa and **Nish Cornish**, Bettye and **Bill Correale**, Nancye and **Gil Cowan**, Una and **Alden Cushman**, Kathleen and **Dippy Davol**, Mary and **Cy Duevel**, Louise and **Ev Elting**, Myra and **Dave Evans**, **Don Fife**, Marguerite and **Mal Finley**, Mary and **John Fitch**, Ruth and **Curly Fletcher**, Lillian and **Myron Freeman**, Ruth and **Bill Giddon**, Hazel and **George Glennie**, **Ray Hamilton**, Dolly and **Ed Hanley**, Claire and **Gordon Harvey**, **Rock Hereford**, Nellie and **Hoyt Hottel**, Bertha and **Max Ilfeld**, Jean and **Tom Johnson**, Ethel and **Gordon Joyce**, Doris and **Dave Kanter**, Frances and **Andy Kellogg**, Ering and **Del Kendall**, Catherine and **Sox Kinsey**, Edith and **George Knight**, Bee and **Dick Lassiter**, Mildred and **Jac Lehman**, Dot and **Ray Lehrer**, Peg and **Pret Littlefield**, Eleanor and **Bill MacCallum**, Kitty and **Frank Manley**, Marjorie and **Fay Marrs**, Dot and **Ev Martin**, Helen and **Perry Maynard**, Laura and **Dave Meeker**, Helen and **Paul Miller**, Rene and **Ed Moll**, Betty and **Don Moore**, Margaret and **Jim Pierce**, **Helen Perrin**, Ann and **Woodie Proctor**, Ettie and **Gene Quirin**, Marion and **Henry Rau**, Saro and **Al Roig**, Lois and **Cam Ross**, Fred and **Nate Schooler**, Barbara and **Frank Shaw**, Helen and **Dick Shea**, Grace and **Mark Sinnicks**, Winifred and **Herb Stewart**, **Herb Stutman**, Jane and **Bill Sturdy**, Anne and **George Tapley**, **Edward Taylor**, **Bill Walterskirchen**, **Rut Torres**, Kathleen and **Marshall Waterman**, Patricia and **Howard Whitaker**, Margaret and **Clarke Williams**, **Paul Blampied**, **Jack Cannon**, **Luis Ferre´**, and **Dick Jackson**.

The advance guard arrived at the Governor Carver Motor Inn on Thursday, May 30. They and all registrants were greeted in their rooms with a welcome token and keepsake from **Ed Moll**, our thoughtful President—a pair of thin, clear, barrel-shaped glass steins, gold-embossed with the M.I.T. seal and "50th Reunion, Plymouth, May 30-June 3, 1974." The next morning, after an early breakfast, buses carried everyone to du Pont Gym in Cambridge to "cap and gown," thence the march to Rockwell Cage and Commencement. Then we were treated to an exquisite buffet luncheon in the courtyard of the Hayden Gallery, courtesy of our own **Luis Ferre´**, ex-Governor of Puerto Rico and founder of the Museo de Arte de Ponce, from which he had a display of 36 works of the more enduring artists of the 19th century.

Then by bus and car, back to Plymouth. Donning the '24 cardinal and white caps and washable clothes, we moved to the Governor Bradford Annex for a famous New England clambake and beer. Anyone who came away without lobster, or still hungry, had an awful short arm, for the Dow Jones Sea Food was over 1,000.

Saturday was to be Sports Day, but the pluvious atmosphere forced us to other occupations. An unusual opportunity for many was an inspection of the Pilgrim Nuclear Power Station, arranged through the efforts of **Herb Stewart** and his New England Power System connection. (It was temporarily not operating because of a government regulation which allowed one man, as an objector, to force a safety hearing. Incidentally, this shutdown was costing us natives $9 million a month for fossil fuel alternatives. **Barbara Shaw**'s indoor program attracted many to various games.

The Class cocktail party preceded a colorful group picture beneath the front marquee from whence we moved into the main dining room, completely reserved for 1924. The table location of each classmate was marked by a white styrofoam box, containing what? The official Fiftieth Reunion memento—a 2¼-in. lucite picture cube, pivoted on a corner above a shapely silver base embossed "M.I.T. 50th Reunion, Class of 1924"—the brain-child of ingenious **Frank Shaw**.

Paul Cardinal, 50th Reunion Chairman, was master of ceremonies and acknowledged the support of his various committees with words and suitable gifts. Five years of productive efforts by **Ed Moll**, retiring President, were recognized with a silver ice pitcher presented by **Cy Duevel**. **Ed Moll** and **Ed Hanley**, 50th Gift Chairman, graciously thanked their respective organizations. **Luis Ferré**, newly elected President of the M.I.T. Alumni Association, revealed the enthusiasm which he will inject into that body. Our honored guest and featured speaker was Paul Gray, '54, Chancellor, who reported on the several issues confronting the Institute in a vein light enough to be suitable for the occasion.

Mike Amezaga presented his Nominating Committee's slate of officers for five years, and election was as short as his hair. The banquet closed with the drawings for exotic Mexican artifacts generously supplied by **Nish Cornish**.

Sunday was the first of Alumni Days, so all leisurely made their way to Cambridge to encamp over night. Many participated in the 2:30 p.m. Memorial Service in the Chapel, meditating on the service to humanity contributed by some 20 of our members. Later in the afternoon, President and Mrs. Wiesner, Dr. and Mrs. Killian ('26), and Dr. and Mrs. Johnson were gracious hosts at a reception in the President's house on Memorial Drive, an excellent preliminary to the International Buffet in the Student Center. Stuffed with beer and goodies, most waddled to the buses for transportation to Symphony Hall, but the Alumni Association surprised a group of us by providing antique cars escorted by a police motorcycle corps.

As the honored Class, we occupied choice front tables to see and hear the indefatigable Arthur Fiedler, in his cardinal jacket, conduct "Tech Night at Pops", his modern white coiffure gleaming in the spotlights—a performance to remember.

Monday was really "Money Day" for us, so for luncheon the Alumni Fund officers placed 1924 members and spouses directly in front of the dais and blocked our escape with 1924-model cars. **Luis Ferre´** acknowledged his pride in his new task of Alumni Association President, and **Ed Hanley**, 50-Year Gift Chairman, approached the microphone to announce his accomplishments. But he was interrupted by a honking horn on the 1924 white Packard roadster, from which **Ed Moll** and Class officers were strenuously unloading a large money bag. This was presented to a beaming President Wiesner as our $675,000 Class Gift, bolstered by $1,600,000 in bequests.

Once more back to Kresge Auditorium for further enlightenment on "Automobility", this year's Alumni Days theme, and then the late afternoon social and *auf wiedersehen* hour in the grassed Briggs Field area, under a beautiful blue sky. *"Forever, and forever, farewell (Cassius).* 50th Reunion! *If we do meet again, why, we shall smile; If not, why then, this parting was well made".*

A financial cloud still hangs over the gaiety: the Committee purchased extra revolving picture cubes, the Class memento minus base lettering, to be sure that no one was denied. The thought was that any surplus would offer excellent gifts for Christmas, birthdays, anniversaries, prizes, family, or friends at the low price of $11 delivered (our cost). They are a new exotic item in the gift market, retailing at $23.50; a conversation piece and available for a limited time from **Frank Shaw**, 65 Arnold Rd., Wellesley, MA., 02181. Frank has reimbursed the Class treasury for its expense and will be glad to reduce his holdings from the cube to the square root. Incidentally, we were too optimistic in collecting only $40 Sunday morning, instead of our originally budgeted $50. Any $10 donors?

We have envelope notes from: **Harry G. Burks**, postmarked Elizabeth, N.J.: "Retired from Standard Oil New Jersey (Exxon) in August, 1964, after 40 years' service with that company and its affiliates. In spite of the golf courses seeming to get longer each year, I am keeping busy and greatly enjoying my retirement." . . . **William P. Hand**: "Am retired, living on Mission Bay, San Diego. For the last three years I have worked for the SCORE organization of the Small Business Administration." . . . **George H. Holmes**: "I was unable to attend the '24 Reunion, but I hope you all had a jolly great time. Enjoying retirement in Paradise, Calif., although I still do a little consulting on mine exploration. I would be happy to see any of my former classmates, if they should happen to be in the northern California area." . . . From **Al Liff** in Beverly Hills, Calif.: "Sorry that circumstances prevent me from joining you all at the Reunion." **Douglas Montgomery**, Ventura, Calif.: "Things go along as usual. Regret exceedingly will not be able to attend 50th Reunion. Congratulations and best wishes to all who do attend (and those not able, also)." **Melvin G. Perkins** politely

questions his affiliation with our Class, but the record disagrees. He is S.B.'22 from Middlebury College (Vt.) and S.M. from M.I.T. in '24 plus Ph.D. M.I.T. '27. He majored in chemistry and most of his career was with E. I. du Pont. We welcome him.

Regretfully, we must name those members whom our Maker has determined have terminated on earth their love of family, comfort of friends, and service to mankind; we share the sorrow of loved ones. **Donald M. Creveling** had S.B. and S.M. degrees in mining. He died May 18, 1974, in Lake Charles, La. "Cactus" was active in the Rifle Club and Mining Engineering Society for three years and apparently spent his career in mining and metallurgy in Mexico and the Southwestern United States.

Weston S. Earle passed away in Wellesley, Mass., on June 20, 1974. Wes received an admirable tribute in the Wellesley paper for his lifelong unselfish work in the community. He lived on a sizeable pond and fostered interest in a power squadron among youth both as an organizer and judge. It appears that much of his time was spent in persistent soliciting of blood donors for the Red Cross; but ironically, Wes himself refused assistance in his final hours, not assured that there was a sufficient supply of the vital fluid.

Sargent D. Heath died April 29, 1974, in a hospital near Shrewsbury, Mass., his home. He received S.B. and S.M. degrees in chemical engineering and spent his life in the textile industry, 25 years as Executive Vice President and Treasurer of the Bell Co. and Washburn, Co., Worcester, Mass. He was an active church member, Mason, and club man. His main interest at the Institute was in wrestling, in which he participated for three years and was manager the fourth.

A nursing home has belatedly reported the death of **Lachlan W. MacLean** on April 9, 1967. We know little except that he had an S.M. in electrical engineering and was connected with the Dampney Co., Hyde Park, Mass. . . . **Dewey Nelson**'s widow reports that he passed away May 25, 1974, in Wellesley. Unfortunately, this is another classmate on whom the record is largely silent; we have very little on his career after his graduation in business management, but we know that in 1949 he was associated with Jackson and Moreland, Engineers, of Boston. . . . **Felix Stapleton** died of pneumonia on May 12, 1974, in Peterborough, N.H. "Stape" was 78, always recognizable at about 6'6" and short blond hair. He graduated in general engineering as a World War I veteran and in 1931 joined the federal government to serve in professional and administrative positions in the Tariff Commission, War Production Board, War Assets Disposal Commission, and Central Intelligence Agency. At the Institute he was a member of our Class crew and belonged to eight clubs and societies.

The Class is the grateful recipient of *A Great History of the Great Class of 1923,* a remarkable book compiled by Arthur W. Davenport, '23, and his good wife. The gift was on the occasion of 1924's golden anniversary and in recognition of **Chick Kane**'s unforgettable contributions to the Class, to the Institute, and to many pages in the *History.* It is a masterful production; write to Mr. Davenport, if you want a copy.

For their constant help before and during the reunion, we are indebted to Joe Martori

Class of '24 at their 50 Year Reunion, clockwise from top right: Gordon Billard and Edward Moll; on line sporting bibs and hats—William MacCallum, Russ Ambach, George Knight; Plymouth clambake; Howard Johnson jokes with the Class of '24; Paul Cardinal (right) talks with John Mattill; "Nish" Cornish, Eugene Quirin.

and others in the Alumni Association; and to **Phil Blanchard** for the badges we wore. At some early time, you will receive the roster of new Class Officers; meanwhile, please send us names and data to supplement all categories of the 1924 Fiftieth Reunion Directory which was mailed to you.

One last-minute reunion comment from Mildred and **Jac Lehman**; they call it "... a magnificent affair all the way through; superior clambake, excellent cocktail party, perfect transportation handling, and details managed beautifully."

From **Rock Hereford**, probably the long-distance winner at the Reunion, comes a nice tribute "for a reunion so well thought-out and organized. My only revision would have been to allow banquet members, so wishing, to extend personal greetings to classmates unable to attend."—**Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, MA., 02146; **Herbert R. Stewart**, Co-Secretary, 8 Pilgrim Road, Waban, Mass. 02168

25

Our class had a fairly good representation present for Alumni Days. The following were present: **Chink Drew**, **Doc Foster**, **Will Gardiner**, **Sam Glaser**, **Jim Howard**, **Ed Kussmaul**, **Fred Sommer**, **Sam Spiker**, **Karl Van Tassel**, **Milt Salzman**, and **Ed McLaughlin**. **Jim Howard**'s replies to his request for class dues give every indication that we will have a banner turnout in 1950.

My wife and I made our trip to the Canadian Rockies and had a wonderful time. One interesting part of the trip was very little news about all the happenings in Washington. Something of a relief. . . . **Stephen Freeman, Jr.**, retired in 1970 after 22 years with Purdue University's School of Electrical Engineering. After a few months of travel in April, 1971, he joined on a part-time basis a Purdue program to retain more enrolled freshman engineering students. He has been asked to continue this for a fourth academic year. His greatest satisfaction is to see borderline students grow strong and able. . . . **Millard L. Caldwell** writes that after another winter in Conadalojora they are back in their home in Sonoma in the Valley of the Moon. Although they purchased it two years ago, they have not settled properly as they have been there about four months since they bought the place. They expect to be there more in the future. . . . **Harold Bishko** writes that he has been retired for five-plus years and is enjoying life in sunny California. He is playing tennis traveling with his wife to visit five children plus assorted grandchildren scattered all over the country. . . . **John P. Ramsey** says that there is no material change. He planned a quick trip to Bermuda in June and hoped to get to New England before the end of the summer. His son's illness restricts his plans.

I am sorry to have to report the passing of the following class members: **Laurent Roy** of Needham, Mass., on February 13, 1974; Miss **Ruth E. Densford** of Brooklyn N.Y., on May 14, 1973, **Edward C. Booth** of Marshalltown, Iowa, on April 13, 1974, **Arthur K. Sun** of Hartsdale, N.Y., on May 7, 1974, Lt. Col. **E. H. Mitcham** of Middlebury, Vt. On December 28, 1973, and **William W. Northrop** of Rochester, N.Y., on May 12, 1974. . . . Thanks to a letter from **Payson Hammond** who divides his time between Florida and Ohio I have some more information about **Ted Booth** whose passing I have noted above. Ted was a native of Newton Centre, Mass., and after graduation he became a traveling auditor for the Actra Casualty Co. It was during this time that he met his wife, and later his father-in-law induced him to join the Lennox organization. In 1940 the family moved to Marshalltown when he assumed financial responsibility for the corporation. He retired as Secretary-Treasurer of Lennox Industries in 1968. He was active in civic affairs and served in many capacities. He is survived by his widow, a son, a daughter, a brother, and seven grandchildren.—**E. Willard Gardiner**, 53 Foster St., Cambridge, Mass., 02138

26

It's a gorgeous mid-August afternoon at Pigeon Cove so please do not expect a lengthy dissertation. We had the Bullseye National Championships here last weekend and became a little saturated with sailing —otherwise I would be out on the water right now. An amusing note from **Jim Drain** (our first in 48 years!) is worth quoting verbatim. "No sail-power for fishing in the Gulf Stream, so **George Smith** will call me a stink potter (sailor name for power boats). He can eat the cups he wins—but dolphin tastes very good to us—Cheerio, J. A. Drain".

All right Jim, I cannot eat the cup, but fish chowder sure tastes sweet when served from them! The July/August issue of the *Review* came today and it contains a complete and stirring story of the naming of the Great Court for our classmate Jim. There is nothing I can add to this fine account but as your secretary I was sitting there—standing I should say because there were not enough seats—reflecting and listening and admiring. The pebbles we remember are now fine turf and the little rhododendron bushes have become small trees and they were all in bloom. The ceremonies were dignified by a crisp and melodious brass quartet. It was thrilling to feel that I was representing those of you who could not attend while the Great Court was becoming "Killian Court".

A letter from Nantucket is signed "Bird". As you may know **Austin Kelly**'s kid (twin) brother summers on Nantucket Island and as near as we can make out he is spending most of his time planning for our 50th reunion. He will have to wear a red jacket instead of one of the loud sport jackets he has always worn but the stories will have the same fervor: Ashbridge does not fool around with serene spots like Pigeon Cove and Nantucket. Two recent letters—one from Cairo and another from Zurich—indicate that a stroke a few years back served only to spur him on. To quote: "Since 1970 we've been on each continent except Australia at least thrice and we may get to Australia one of these days." . . . Whit's recent trip to south and southwest Africa included a hunting safari and the only animal I ever heard of among those he bagged was a springbok.

As you know, on Alumni Day there is a Memorial Service for M.I.T. Alumni and at this years service there were 15 of our classmates listed. I believe I have told you about all of them in the notes during the past year. Now there are two more. **Saul Brodsky** died in April and **Martin Walter, Jr.** who had been ill for some time succumbed in May. They were always at our reunions and we regret that they will not be around for our 50th but we will surely be thinking of them. For now—Cheerio—Usual finis.—**George Warren Smith**, P.O. Box 506, Pigeon Cove, Mass. 01966

27

I have some happy news to start off with. On May 8, **Ted Ordman** was married to Mrs. Valda Oarkin of Montego Bay, Jamaica, West Indies. After a honeymoon in Europe, they now divide their time between a summer home in Stanfordville, N.Y. and a Brooklyn apartment, but they expect eventually to spend winters at Valda's home in Montego Bay and summers in Stanfordville. Ted writes, "Valda's blessed advent into my life after I lost Kathryn has brought new hope, new happiness, and new contentment." He promises to bring her to the 50th reunion to meet all of us.

And on May 28, **Fran Bonnar** was married at Westport Point, Mass., to Albert E. Hendershot. The Hendershots and Bonnars were old friends from Fall River and Mr. Hendershot had worked with Bob at GAF. He was widowed a year or two before Bob passed away. The Hendershots spent the summer at Westport Point. I know that all the class joins me in wishing many years of happiness to the Ordmans and the Hendershots.

Marion and I were in Cambridge for Alumni Day and enjoyed it thoroughly. We were somewhat disappointed at the relatively small representation from our class, though it was typical of those classes of our generation which were not holding quinquennial reunions. Because the luncheon was the only event at which all the class was seated together, we missed one or two of those attending, but the following were registered for the week-end: **Dike Arnold**, **Joe Burley**, **Ed Chase**, **Bud Fisher**, **Harold Edgerton**, **Dick Hawkins**, **Morris Leonard**, and **Harland Sisk**.

Bill Taggart had planned to be there, but in March he suffered a stroke. **Bud Fisher** tells me that Bill is out of the hospital and in a rehabilitation center, and making some progress. . . . Bud and Hope Fisher are well, and enjoying life on the Cape.

Bud also straightened me out on a slight error in the announcement, in the July-August Review, of **Jim Chamberlain**'s death. I had received a garbled report that Jim had moved to Duxbury. Actually, Jim died in April at his home in Akron; it was Bud's neighbor in Duxbury, John Chamberlain '28, who died there in January.

While I am correcting errors, **Joe Yates** writes that I was misled in interpreting a change of address notice for him from Wyandotte to Bartlesille, Oklahoma, as an indication that he had moved. The Bartlesville address is the home of his daughter, and when Jim and his wife are travelling, they have their mail forwarded there. Joe retired from BASF Wyandotte five years ago, but continues to make his home base in Wyandotte. . . . He mentions that he visited Alice and **Charlie Hurkamp** last year at Hilton Head Island, South Carolina, and found them enjoying retirement; Charlie has become a golfer.

Isabelle and **Lloyd Bingham** are spending

their winters in Boulder, Colorado and summers in South Hero, Vermont, since his retirement in 1968 after over 40 years of teaching electrical engineering. "We enjoy being part of two communities, a city by the Rockies and a village by Lake Champlain," he writes. . . . Four years ago, **Nat Mintz** retired as a patent examiner in the U.S. Patent Office, and now he has himself applied for a patent on a game he has invented, which he calls "Kickgolf." He tells me he would like to promote it through a non-profit corporation, with the profits to go to M.I.T. and other beneficiaries. He would be happy to supply details to any classmate interested in helping to establish such a foundation, and expresses a willingness to exhibit it in New York or any other East Coat location. He can be reached at 10,612 Cavalier Drive, Silver Spring, Md. 20901.

I have been putting off the obituaries as long as possible, but there are, unhappily, two more to report this month. **Norman Hurd** died at Houston on April 27, and **Jim Frink** at Mercer Island, Wash., on May 4. I well remember Norman from our undergraduate years. He was one of the youngest members of the class, if not *the* youngest, and he had a photographic memory. If my own memory is not playing tricks, he was the classmate who astounded us all by memorizing the table of five-place logarithms. He spent most of his working career with Texaco. . . . Jim had been President of Washington Iron Works in Seattle.

About the time you read these notes, Marion and I will be somewhere in Great Britain, or perhaps in the Low Countries. We had reservations for a trip to Greece and the Eastern Mediterranean, but after reading the headlines in the past few days (this is written in mid-August), we cancelled out and decided to take the risk of IRA bombs instead. Why do people hate so?—**Joseph H. Melhad**, Secretary, 24 Rodney Road, Scarsdale, N.Y. 10583

28

We regret to report that **Ralph M. Evans** died on January 29, 1974. Ralph graduated in Course VIII, devoted most of his professional life to research in the science of color and photography and was with Eastman Kodak Company until his retirement in 1970. He was the author of several books and numerous technical papers and often lectured on subjects related to the perception and psychology of color. To his wife, Pauline, and their family we express our heartfelt sympathy.

Alumni Days activities this year were attended by **Maury Beren**, Frannie and **Jim Donovan**, Gladys and **Dave Olken**, Rudy Slayter, Walter Smith, Ann and Will Tibbetts, Sam Weibel and Abe Woolf. . . . **Sam Weibel** says that the latchstring is always out for passing classmates at his summer home in Hollis, N.H. . . . From **Maury Beren** we learn that the **John Gordon Collins'** are enjoying their condominium near the Berens and the **Sidney Browns** at Palm Beach, Florida. We are especially pleased to have news of John since we have been out of touch with him for some time. Peggy and **George Mangurian** are planning a trip to Rome, Florence and possibly Dubovnik in September or October. George had to undergo some surgery last February but says that everthing turned out well. In March the Mangurians spent a few days at Winter Haven, Florida with Anne and **George Palo**, Grace and **Ed Ure**, Madeline and **Hal Porter**, and Doroty and **Herm Swartz** "for a sort of mini reunion". Ed is planning to retire at the end of this year. . . . **Harold Block** writes that he is engaged in development and management of privately owned mining property in Yavapai County, Arizona. . . . **Gene Boehne** plans to attend the biennial Paris meeting of International Congress on High Voltage Systems (CIGRE) August 20-29, 1974. . . . A note from **Arch Archibald** came from Wolfville, Nova Scotia where he was on a short family visit. He reported the weather mixture as "some good, some bad and some very bad." . . . A newspaper photograph from the *Herald American* (Boston) shows three distinguished gentlemen as they received Good Scout awards this summer from Paul Langley, President of the Cambridge (Mass.) Boy Scout Council. The recipients were Edward A. Crane, former mayor of Cambridge, Howard W. Johnson of M.I.T. and our classmate, **Gustave M. Solomons**.

The **Florence Jope—Walter Smith** wedding on June 22 in Winchester, Mass. went off beautifully with perfect weather. Frannie and **Jim Donovan** were the gracious attendants. A few local classmates were also there plus Mary and **Max Parshall** from Montana who were visiting in the East. The wedding trip included a flight to the West Coast; a tour through Seattle, Victoria (B.C.), the Canadian Rockies, Jasper, Lake Louise, Banf, Calgary and a motor tour of the Boulder, Colorado—Rocky Mountain National Park area. For sheer beauty and variety of scenery these parts of the continent are hard to surpass. Other travels during the summer provided pleasant opportunities to visit with Elva and **Walter Anderson** in Harwich, Mass., Priscilla and **Roger Haven** in Fryeburg, Maine and with Susan and **Jim Tully** who also live in Fryeburg. . . . The many heartwarming letters, notes, and cards of congratulation and good wishes from the class were wonderful to receive and highly appreciated.—**Walter J. Smith** Secretary, 37 Dix Street, Winchester, Mass. 01890

29

Our 45th Reunion was a great success, leaving many pleasant memories in the minds of those who attended. Though the attendance (approximately 80 including wives and friends) was not as high as expected, most of those who came remarked that they thoroughly enjoyed all the activities and the program which the Committee had arranged in the relaxed atmosphere of Chatham Bars Inn. Among those who attended their first reunion were: **Milton Male** and wife Macine from Pittsburgh, Pennsylvania who promised to return for our 50th and **Richard Piez**, accompanied with his two sisters from San Mateo, California.

Highlights of the reunion activities were an outdoor clam bake Friday noon; a fishing party which included **Dick Piez**, **Bill Baine**, **Ruth Earle** (who caught the biggest fish), **Paul Baker** and his wife, and **Ed Perkins**; and a cocktail and dinner party Saturday night followed by movies and slides of past reunions. A brief business meeting was held for the election of Class Officers who will be serving for next five years. Those who were nominated and elected were: **William Baumrucker, Jr.**, President; **Walter H. Gale**, Vice-President; **Malcolm M. Hubbard**, Treasurer; **Karnig S. Dinjian**, Secretary; **Frank Mead**, Class Gifts Chairman; **Bill Bowie**, Class Agent; **John J. Wilson**, Estate Secretary. Sunday evening **John** and **"D. A." Wilson** hosted a cocktail and buffet dinner for our reunion guests at their home in Brookline which was attended by a goodly number. John had arranged for a bus to take those who had planned to attend the M.I.T. Night at the Pops, which was filled to capacity. Activities ended on Monday, Alumni Day, which had a good representation from our class. Those who attended were: **Paul S. Baker**, **William Baumrucker**, **Arthur J. Bearse**, **W. Gordon Bowie**, **Frederick L. Bray**, **Putman Cilley**, **Karnig S. Dinjian**, **Frederick B. Danner**, (Mrs.) **A. Ruth Dean**, **John J. Fahey**, **Leo Goldstein**, **Ellie Horwitz**, **John McCaskey**, **Frank Mead**, **Walter Partridge**, **Leonard Peskin**, **Jim Reddig**, **Norman M. Wickstrand**, **David H. Wilson**, **John Wilson**, **Richard Piez** and **Thomas H. Speller**.

Romance is still possible for our age group. **John Fahey** presented his bride (Ruth) of one week at the Reunion. . . . **Stephen N. Dilworth** had been courting Mrs. Murry Mynne Corlett with a little encouraging remarks from Helen Dinjian in the role of a "matchmaker". Confidentially, Myn changed her "maybe" to "yes". A wedding announcement showed that they were married on June 21, 1974. . . . Helen the "matchmaker" prodded **Richard Piez** towards the same goal (no objections raised by his sisters) with doubtful results.

Received a letter of appreciation from **Ed Pawley**, who missed his first reunion because of his wife's illness, as follows: "Dot and I would like to thank all those who remembered us and sent their greetings from Chatham Bars Inn. It gave Dot a great lift to see all the signatures of so many old friends. We greatly regretted, due to circumstances, missing our first reunion." . . . A similar letter came from **Hugh Hamilton**, from Durham, New Hampshire, who "greatly appreciated the greetings from so many friends" and regretted not being present. "**Bill Young** and his wife Joan," Hugh continues, "stopped in for over night at our home in Durham and gave us a first hand report of the 45th Reunion. We will be leaving for Florida after September and would welcome visits from Twenty-Niners who plan to be in New Hampshire or Florida." . . . A note from **John P. Ruk** states; "Thanks for the kind wishes. We missed the reunion because we had to make a choice between a planned trip to Yugoslavia and Greece or the reunion, and the former won out. We had a delightful time with Dan and Betty McDaniel as traveling companions. We had many new experiences, including losing ten water pump belts of our hired car while touring in the mountains of Yugoslavia. Best regards to all."

A note from **Clayton F. Jarvis** reads: "Still plugging along as Construction Engineering for G.S.A. with headquarters in Region I in Boston. Territory includes southern Maine, southern New Hampshire and northeastern Massachusetts. Our daughter is a junior at Wellesley. I just celebrated my 68th birthday and will probably retire within a year." . . . **Jonathan F. McCray** writes:

"Though I am retired, I do keep busy doing volunteer work with the Cancer Association and the American Association of Retired Persons. I am also trying to get a viable Republican Party started in the county (Ark) to insure a two party system. My wife and I enjoy our home and taking care of the grounds surrounding it. Many thanks for the birthday greeting, which I enjoy receiving." . . . "There is a saying" writes **Charles Frank**, "that a person hasn't been anywhere until he has been to the Kentucky Derby at Churchill Downs. So, on Friday, May 3, 1974, I flew to Louisville with an 80-year-old friend, who has been a great horse man all his life. The next day we drove out to the track and watched the one-hundred-running of the Derby with 165,000 spectators to see Cannonade win by two and a quarter lengths. This was a wonderful experience." . . . **Hunter Rause**, who retired from the University of Iowa as Carver Professor Emeritus, writes: "Though I sent you a card from Caracas thanking you for the anticipated birthday greeting, here is another 'thank you' for the same reason. Sixteen of us in the Water Resources field expect to go to mainland China for a month in middle of August. I'll send you another post card, but I doubt that it will reach you. Sorry Dot and I will miss the 45th Reunion, but we are counting definitely on the 50th. Again my compliments on the contents and regularity of the Class News in the *Review*." . . . **Edwin H. Perkins** writes: "I have now been retired for three years from Bell Telephone Laboratories after 41 years of service. It was a very interesting experience watching our telephone system expand from a handful of cross-country circuits to a system of communications that covers the country like a web. Retirement has proved very rewarding; I am able to do so many of the things in life which I was unable to do while working. I am active in boating, have a 26 foot sloop to enjoy in the summer. I have just completed a tour of duty in the Merrimac River Power Squadron as Commander, and I am now an Educational Officer. I have renewed my interest in Masonic and Eastern Star affairs which I never had the time to follow while working. We are also doing some camping, having bought an 18 foot motor home, which enables us to enjoy the New England forest in the spring and fall." . . . **Larry Moses** sends his best wishes to his friends renewed at the 40th Reunion and his regrets for his inability to attend the 45th." Sarasota, Florida, is a bit too far for us to travel to the Cape. Kay and I are healthy and enjoying playing golf, swimming, traveling and many other local activities. We have made some new friends here and we enjoy their company." . . . **Jackson H. Emery** writes; "I am retiring as Director of the Libby Museum of Transportation in Wolfboro, New Hampshire, which I have directed for ten years. I urge all classmates to take the steam train ride (standard gauge) on the Wolfboro Railroad, which will prove a very enjoyable experience."

Bill Bowie has sent a note as follows: "Dear Karnig, thank you for the birthday greetings, which I think was a good idea, having produced some good results. To bring you up to date, I retired from the telephone company in February, 1971. Since then, we have divided our living time between Slingerland and Highfield, our permanent home in the Adirondacks. We sold our home in Slingerland and rented an apartment for those occasions when we wanted to be there. We have had two fine trips since retirement, one to Norway, Sweden, Denmark and Finland in 1972; and in 1973, we spent nearly two months on a trip to Alaska. We went by auto over the Alcan Highway and really had a great time. We returned via the Inner Passage and along the coastal area of Washington and Oregon. This year, we had planned a trip to Florida, but the gas shortages discouraged us. We are looking forward to being at the 45th Reunion, arriving on May 30th where we hope to see you and other friends and classmates. This will be our spring vacation."—**Karnig S. Kinjian**, Class Secretary, 6 Plaice Cove, Hampton, N.H. 03842

The air was light and the action slow, but in this picture George Warren Smith, '26, in the left boat, is well on his way to fulfilling a 6-year dream by winning the National Bullseye Championship off Rockport, Mass. on August 10.

On the Money in a Bullseye

George Warren Smith, '26, has been sailing a Bullseye—a 16-ft. dinghy—for 6 years and racing one in the national competition off Rockport, Mass. for half that time. And he had a goal for himself: "It was always my hope to win the nationals by the time I was 70," he told Peter Watson, Editor of the *Gloucester Daily Times*, "but I never thought I would."

On August 10 Mr. Smith, whose monthly reports from Pigeon Cove are a highlight of his contributions to *Technology Review* as Secretary of the Class of 1926, achieved his hope with just about a month to spare, ending his frustration as a "bridesmaid" in the competition. He previously had finished fifth, fourth, and third.

It was close all the way. Mr. Smith won the first race of the national competition—14 boats were entered—after the defending champion was involved in a collision (minor, no damage) with another boat just before the start and so was disqualified—and never regained the lead he needed. The final race found Smith the underdog, behind at the first four marks of a five-legged course. But the wind died on the long downwind leg to the finish, and in the near-flat calm Smith's spinnaker (*see photo—Smith is sailing 670*) pulled him home first.

"Usually the breaks go against you, but this time they went our way," he told Mr. Watson.

30

Regular readers of the Review will doubtless have noted the retirement of **George Wadsworth**, Professor of Mathematics and my predecessor as Class Secretary, after 40 years on the M.I.T. teaching staff. Details are given on pages 87 and 89 of the July/August issue. One of George's outstanding achievements was the adaptation of Norbert Weiner's theory of prediction to the fields of meteorology and oil prospecting. George's retirement is quite timely in one respect, since it should give him additional time to work on the plans for the 45th Reunion.

Arthur Griffith has retired from Lukens Steel Company and has moved to Summer-

ville, S.C., where he is "relaxing, golfing, gardening and enjoying becoming acquainted with historic and romantic Charleston and the plantations of the low country." . . . **George Lawson** has retired from Sylvania and is spending winters in Stuart, Fla., and summers in Maine enjoying the golfing, fishing and swimming at both places. He reports having seen **Ralph Rowzee**, **John Hanley** and **Jack Bennett** and that all are fine and enjoying life. . . . **Charles Twelves** has retired from Pacific Northwest Bell Telephone Co., Seattle, Wash., as assistant VP-engineering. He did not disclose his retirement plans. . . . **Ron Hepburn** retired as of July 1 from Horn Construction Co., Inc. (a Halliburton Company) where he served as vice-president-engineering. He is presently combining retirement activities with limited continued participation in his company's affairs. . . . **Harry Poole** has retired and is living in McLean, Va., where his main hobby is gardening. He has a collection of over a thousand azealas of many different varieties.

Sebastian Littauer, Professor Emeritus of the Department of Industrial Engineering, Columbia University, received the 1973 Shewhart Medal of the American Society for Quality Control "in recognition of his accomplishments in quality control under the initial influence of Walter A. Shewhart and for his pioneering accomplishments in management sciences." Dr. Littauer has been vice president of the Israel Institute of Technology, Chairman of the Mathematics Department, Newark College of Engineering, and has taught at the U.S. Naval Academy and at Hunter College. He is a Fellow of A.S.Q.C. and the American Statistical Association and in 1969 received the Great Teacher Award from the Society of Older Graduates, Columbia University School of Engineering and Applied Science.

St. George Arnold is working as a consultant to the Oakridge Operations of the U.S. Atomic Energy Commission in the field of power procurement economic analysis. . . . Supplementing an item in the March/April issue of the Review, **James Rice** reports that he recently celebrated his 80th birthday and stopped working. He was a regular Army officer from 1917 to 1946 and retired as a Colonel. During this period he attended M.I.T. and received a Master of Science degree. Thereafter he worked for about 15 years in textile engineering and instructional work for the National Institute of Dry Cleaning and in 1961 became a consultant for the Textile Museum in Washington, D.C., specializing in the conservation of rare and historic textiles. He has also served on the staff of the Winterthur Museum at Winterthur, Del., and the National Park Service at Harper's Ferry, W.Va. . . . **J. A. Dickson Rapp** is an architect and engineer in Glasgow, Ky., where he is a member of the Planning and Zoning Commission and of the Board of Adjustments.

John Pratt retired some years ago because of health problems and is living in Castine, Maine, where he maintains quite an active retirement schedule. He is busy with politics as GOP Town Committee Chairman, County Committee Member, County Finance Chairman, Town Tax Collector and Chairman of the Zoning Board of Appeals. He also operates Pratt's Photo Service and is active in a YMCA childrens' swim program. John has continued his interest in singing and has sung in his Church choir for more than 25 years. He suggests that those of you who sang with him in the Glee Club might be interested in the fact that after giving up smoking in 1957 his voice started changing again and he became a tenor. This item will allegedly be of particular interest to **Bob Ottaway**. . . . We have at hand notices concerning the death of several more of our classmates: **Roy Ide** on May 4, 1969, **Garret Green** on September 19, 1973, **Hazen Sise** on February 17, 1974 and **Earl Krall** on May 29, 1974. Unfortunately, very few details are available. The only information I have on Roy is about 10 years old. At that time he was head of the Science Department at Mitchell College in Statesville, N.C. Garry Green retired a number of years ago from his job with the Atlas Cement Division of U.S. Steel Company and was living in Great Barrington, Mass., at the time of his death. As of seven years ago, Hazen Sise was an architect in Montreal. Earl Krall was Director of Statistical Services, Boy Scouts of America at the National Headquarters in New Brunswick, New Jersey. He had served as secretary, treasurer and president of the New Brunswick Lions Club and as a Lions Club Deputy District Governor. He also served as a Director of the Y.M.Y.W.H.A. and was chairman of the Parents' Council of the New Brunswick public schools.

Changes of address: **Mark C. Culbreath**, 4550 Warwick Blvd. #509, Kansas City, Mo. 64111; **Donald W. Diefendorf**, Hedge Lane, Cazenovia, N.Y. 13035; **John M. Cleary**, 1000 Wiedman Road, Ballwin, Mo. 63011; **Robert W. Clyne**, Edens Equip. Co., 5701 Sheridan Road, Rte U-25, Chicago, Ill. 60660; **Howard A. Robinson**, Wilderness Community, Mount Holly, Vt. 05758. —**Gordon K. Lister**, Secretary, 530 Fifth Avenue, New York, N. Y. 10036

31

Welcome notes were received from two of my old ham radio friends, **John Dyer** and **John Hollywood.** John Dyer writes that he is retired in New Hampshire, a lovely area, and John Hollywood says he is still enjoying ham radio (W1SK), a bit of mild hiking and relearning dancing. . . . Word from **Henry Hartwell** tells us that he and his wife spent a pleasant month (April) in Florida, including a few days with **Clifton Smith** and his "lovely" wife, Dorothy, at Stuart, Fla. . . . **Arnold True,** Emeritus Professor of Meteorology, University of California at San Jose, has retired to a cattle ranch in the Santa Cruz mountains. . . . **John Slavin** has retired as General Traffic Engineer, Massachusetts Area, New England Telephone and Telegraph Company.

More retirements! **Harry Wagner** writes that he retired as of December 31, 1973 as Chairman of the Board, Southern Brick Contractors, Inc., Richmond, Va., and **Leland Gibbs** advises that he is retiring on November 1, 1974 after 40 years in Rome, N.Y., and Revere Copper and Brass, Inc. . . . Still more retirements are **Franklin Dewey** from Eastman Kodak and from the army as Lieutenant Colonel, and **Joseph Pasell** from The Vermont American Corp., in Greenville, N.C. in April 1973 as plant engineer. Joe is now a private consulting engineer handling special machine design in the North Carolina area.

I don't know who put in the comment about me being given a summons for driving 25 m.p.h. in a 45 m.p.h. zone, but it's true. The summons read that I was doing that on Route 202 in New Jersey and there was no 45 m.p.h. zone where I was followed—and that I was doing the same on Lonng Hill Road—and there is no Lonng Hill Road, and that my car was licensed in New Jersey instead of in Connecticut. Still I was found guilty and fined $15. Moral: be careful when driving through Oakland, N.J. Those attending Alumni Day this year were **Larry Barnard** (our 45th Reunion Chairman), **Art Donovan**, **Ted Morrill**, **Art Newell**, **Arnold Nylander**, **Howard Richardson**, **Tony Savina** and **Al Ziegler**

Leon Osinski reports that he retired on June 30, 1974 as Dean of Instruction, Del. Tech and Community College after 37 years with the State of Delaware.

Word has been received of the death of Dr. **Albert H. Cooper** on April 19, 1974. Our deepest sympathy to his family.—**Edwin S. Worden**, Secretary, 35 Minute Man Hill, Westport, Conn. 06880; **Ben W. Steverman**, Assistant Secretary, 260 Morrison Dr., Pittsburgh, Penn. 15216; **John R. Swanton**, Assistant Secretary, 27 George St., Newton, Mass. 02158

32

Don Gilman, our distinguished past Class President, has recently entered semi-retirement as Chairman of the Board of Warren Pumps, Warren, Mass., and will serve as a consultant and advisor to the firm for the year or so. Don and Doris vacationed in London and Iran in October, 1973, and in London and Ethiopia in October, 1972. This year they are planning a tour of Tunisia, Yugoslavia and Malta. . . . **N. E. Rothenthaler** recently advises that he retired from Ford Motor Co., in 1968 and is now located in Largo, Fla., where he stays very active in the SCORE (Service Corps of Retired Executives) and I.E.S.C. (International Executive Service Corps) programs. He is serving at present as President of the County Chapter of S.C.O.R.E., and has had two assignments in Columbia, S.A., for I.E.S.C. has kept him very busy. One of his twin daughters, Judy, is now Associate Professor of Law at the University of Maine and the other resides in Venice, Italy. . . . **Ken Smith** reports his retirement from Armco Steel Corp., December 1973, and that he and Betty (Tatterson) are thoroughly enjoying their eight grandchildren in Idaho, Ohio and Connecticut. . . . **Jacob Millman** is on sabbatical leave from Columbia University this year and has lectured on digital electronics at the I.B.M. Laboratories in Holland and Germany, a continuing two weeks course in each country. He also lectured in Athens, Greece and LaGaude, France and spent a semester at the University of Tel Aviv, Israel, giving two courses on integrated electronics. His son, Jeffrey, is an instructor at the Institute, while doing his Ph.D. work and son Richard has been promoted to Associate Professor of Mathematics at the University of Southern Illinois. . . . **Lester N. Stanley** is enjoying a happy retirement for the past year after 38 years in the chemical industry, mostly with G.A.F. Corp., where he managed to accumulate 64

U.S. and numerous foreign patents, mainly in the field of new dyestuffs for synthetic fibers. Travel, gardening and music hobbies keep him and his wife busy, as well as visits to the two grandchildren in each of the mid-west families of his son and daughter. . . . **Herman G. Protze, Jr.**, has been elected to a Fellowship in the American Concrete Institute. Herman has served as a charter member and Trustee of the Massachusetts Concrete Industry Board. His beloved wife Ethel Mitchell Protze died February 17, 1972 and he married a sister of the actor Wendell Corey, Julia Corey, March 17, 1973. . . . **Robert T. Shipp** joined the retirees the first of last year and is presently traveling the Orient, Europe and U.S.A., enjoying visits to children and grandchildren. . . . **Charles M. Thayer** retired last October as Manager of Real Estate, Development Department, E. I. duPont de Nemours and Co., Wilmington, Del. He has started working a three-day week, Tuesday, Wednesday and Thursday on January 2, 1974 as an engineer-consultant for the All States Engineering Co., of Trenton, N.J., assigned to its Wilmington office. That activity and his seven grandchildren keep him very busy. . . . Your Secretary was the recipient of a most pleasant surprise from **Thomas E. Smith**, a copy of his personal treatise on the history of the Maytag Co., Research and Development Division. Tom prepared, edited and had printed at his own expense this excellent historical booklet and presented a personally autographed copy to each member of the Maytag Co., Research and Development Division as a personal gift. I am very flattered to be included in such select company. Tom retired from Maytag Research in March.

The Alumni Office reports that the following classmates, **Donald Brookfield**, **Douglas Miller**, **William Pearce**, **Herman Protze**, **Harold F. Tonsing** and **Thomas Weston** attended Alumni Day '74 activities. . . . **Richard M. Stewart** now the Commissioner, Department of Commerce, State of Connecticut is learning government can be a bit different industry. Dick reports "life as a bureaucrat is a totally new experience." He resigned as President and Chairman of Anaconda American Brass Co., last year to take his present position with the State. . . . **Ebed L. Ripley**, as reported to me by Tom Sears, has retired from Liberty Mutual after almost 42 years, very hale and hearty, and looking forward to his retirement. . . . Supplementing the notice in the mid-summer issue of the *Review* on the sudden passing of **William Schuler**, I have received a very gracious note from Carl G. W. Swanson '33, which reads in part as follows, "Bill was a good family man and loved his home and family. He loved people and as a consequence people liked him and he got along with everyone he came in contact with. His family and friends will grieve and miss him a great deal."

It is with deep regret I report the passing of **William H. Barker** on April 28, 1974, **John J. Such** on June 29, 1974, and **Gordon S. Clark** on June 30, 1974. Our heartfelt sympathy goes to their respective families.

Professor **Albert G. H. Dietz** was granted the Walter C. Voss Award for 1974 by the American Society for Testing Materials (A.S.T.M.) during the 77th Annual Meeting of A.S.T.M. at Washington, D.C., June 28, 1974. Al received the award for "his long and valued service to the construction industry."—**John W. Flatley**, Secretary, 6652-32nd Street N.W., Washington, D.C.

Lucy Henning and an elephant.

33

"Again, the time has come, the Walrus. . . . things." At the luncheon on Alumni Day, I visited with Lucy and **George Henning**, who had recently visited Kenya. This was a camera hunt, God bless 'em, and George had with him a picture of Lucy and an elephant. Our esteemed secretary for 20 years, George has been on every fund raising committee, every reunion committee but one or two, and involved in about everything else that we have done. George never has to be asked; he is always there and ready.

We have two missives from **Cal Mohr**, a fellow who writes to me more often than many others combined. Cal sat beside a stranger on a plane earlier, who told him that **Monroe (Andy) Kessler** is now with Great Lakes Steel, Detroit, after being with Weirton Steel since graduation. Cal seems to think that this move, if it did take place, is a great step up for Andy. . . . Cal went to Rochester awhile ago to attend the wedding of a niece, and got some gossip. **Red (Bob) Smith** is still antiquing (a store), and going great guns. He also appears to be busy repairing and caning furniture. Red's children are scattered all over, Maine to Idaho. I'd sure like to hear from Red himself just once. . . . **Walt Swanton** is still very busy in the operation of many of the Pfaudler plants, and contemplates retiring, though this is not a definite commitment. . . . Now for Cal himself: he will retire from D.R. Sperry and Co. as of October 31, 1974. Golly, that's Hallows Eve. The Mohrs will move to East Liverpool, Ohio (that was Liverwurst when I was in Ohio), and so will be near Jean's family, and much closer to Cal's brother and sister in Rochester. Well, he could have split the difference and lived in Ashtabula. With no doubts whatever, Cal is qualified as a consultant in the filter business, and he expects to set up an office in his home . . .

Art Hungerford writes that he appreciates my work as Class Secretary! Art allows that it was impossible to attend the 40th, as he had long planned a trip to Montana and the Rockies country. They bought a small but efficient travel trailer and visited their granddaughter who lives in Montana. Then they visited the parks: Yellowstone, Teton, Bryce, and Zion, with stops to visit friends en route. Renting a house in Salt Lake City, they returned to it for a five-month visit, which included teaching telecommunications and some other courses at the University of Utah. This took up the winter and spring terms. Art, I spent three weeks in Montana on an Angus promotion tour several years ago, in the west, central, and southwest sections: Your adjectives are apt: big scale, mountains, mines, lakes, winds, snows, ski slopes, etc.—beautiful. Art, you left out ranches, and I saw 25 of them, and they were marvelous. I found two men, my age, both descended from my great grandfather; you figure the relationship. Art says that he is retired, theoretically. But he allows that if he wishes to use the trailer to visit New England and the South, retirement is at least a bit temporary. Art, you can also drive to Mexico City, come March, for the M.I.T. Fiesta. This is not an idle suggestion.

We have a dandy pair of press releases mentioning **Ralph Cross** in *American Metal Market*, a trade paper. One was a news release, and the other was a report on a speech Ralph made to the Machine Tool Builders, of which he is Vice-President. Ralph is very optimistic about the prospects of the industry through 1980. In his speech, he deplores several suggestions on taxation of American firms which operate plants in foreign countries. But, though anxious, Ralph feels that our investments are safe in the predictable future.

Charlie Quick mentions the passing of **John Logan**, of a stroke, which followed several previous strokes. Charlie and John were fraternity brothers in school (Beta Theta Pi). Widow Dottie is still living in the condo at 600 S. Ocean Blvd., Boca Raton, Fla. 33432. . . . Charlie has several spots: Birmingham, Mich., Higgins Lake, Mich., and Hillsboro Beach, Fla. On April 13, 1974, he married Lynn Allerton and acquired all at once a family of four, ages 12 to what looks like 15. Grandpaw used to claim only a lazy man took this easy way out: haw! . . . **Ellery Clark** has changed his address; it will appear elsewhere. He is now working on the B-1 program, which may be the last of his job-shopping before his retirement. He missed me in Florida the time of his Caribbean cruise. How the heck can anyone miss me? . . . **Leighton R. Richards** has two daughters living in California; one of them has two sons. Son Glen is a senior in chemistry at B.Y.U. and youngest daughter is a junior at the same school. . . . **Bill Huston** saw **Clint** and Audrey **Backus**, in Belair, California, while he was attending U.C.L.A., taking a course in physical oceanography. The Backuses have a second home in Atascadero, where they raise barley by the great acres, dryfarm, fallow field method. Bill allows that he never did understand this method, which, glory be, makes two of us, and one of us never heard of it. . . . **Fred Aldridge** is retired from his job with the environmental people in Seattle, and is now a professional engineer in charge of water supplies, Dade County Department of Public Health, Miami, Fla. It seems that there is no mandatory retirement stuff in Florida and Fred wants to work until he is 80, if he feels like it and his health allows. . . . **Dick Faldetta** has retired from N.A.S.A. Research Center, Cleveland, and is loafing, or so it seems. Why not? And after 30 years with the government? He and his Mary Kay just celebrated their 32nd anniversary. Their elder daughter is teaching in New Jersey, and the other daughter is teaching in Kurri Kurri High School in Australia. Son Steven is em-

ployed at N.A.S.A., Cleveland, and the younger is still in high school. Dick plays tennis, bridge, and golf in that order of skill. He also does volunteer work for his American Legion Post. Golly, Dick, that is the first time anyone came up with that excuse for loafing. . . . Ruth and **Bill Barkley** have moved to their small farm in Hampton, N.H. Bill has retired from Project Manager, Real Estate and Construction, G.E. at Schenectady. He plans to continue such work on a consulting basis, and perhaps call on me. . . . **Alfred Payne** (the St. L. Payne) is retired or will be, soon, and will move to Sun City, Fla. . . . **Ben Herlich** says that his son, Richard, will graduate from Carnegie-Mellon in November as a chemist, and has been accepted at the University of Rochester for graduate work. . . . **Jack Adelson** has a quickie: daughter Robin is graduated from Trinity and will attend the University of Chicago. Sharon attends American University in Washington, D.C.

Now for the listing of address changes: **Frederick F. Aldridge**, CE; **Werner C. Bachli**, EL; **L. Hart Cirker**, CH; **Ellery D. Clark**, ME; **Alton J. Deutser**, MG; Rev. **Bernard F. Doucette**, AA; **Melville Ehrlich**, CM; **James F. Merritt**, MG; **Charles E. Quick**, EE; **Charles P. Woods**, MG; and **Fred L. Brugger**, AA. Write me if you want details.

That's it for this time around. Use the Florida address starting in November, though the New Hampshire address is good any time of the year; our farm man forwards mail to me anywhere. So we live in hopes.—**Warren J. Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, N.H.

34

Just about all the 80 members of this class that I reported as coming to the reunion in the last issue were able to come. Almost the only last minute cancellation was **Cass Belden** from Canada who found himself appointed as an employer delegate to the International Labor Organization in Geneva that was held at the same time. So unfortunately, he had to bow out.

Our weather was what we have come to expect at our reunions—about 50% mist or drizzle. But reunions are for yakking and poor weather doesn't bother that. So I think everybody pretty much enjoyed themselves; at least the rain wasn't like that at the 25th—almost nothing could approach that. This was a year to elect class officers and the results are: President—**Charles Lucke**; Vice Presidents—**E. Philip Kron**, **William Ball** and **Norwan Krim**, Treasurer—**Laurence Stein**.

There were two Mickey Finns administered during the election so as you will see at the end, the Secretary and Assistant Secretary remain unchanged. Still to be filled is the position of Class Agent. Our final piece of business was to review the state of our treasury. It was sufficiently healthy so that we voted to contribute $1500 in addition to the almost $400,000 that **Frank Milliken** and his committee had raised for our 40th Reunion gift.

Since this was one of the special reunion years, I think a number of us made a particular effort to go to Alumni Day—there were 23, mostly complete with wives—much the biggest group I can recall in years. It, too, was enjoyable and I don't think I'll wait five years before going to the next one.

Last issue I mentioned that **Frank Moore** had written explaining why he couldn't make the reunion. There wasn't time to include it then, but here it is now. As you read his comments about the stock market, remember the letter was written in the middle of May and these notes the middle of August—I hope he at least made it to South America. Frank writes: "Thank you very much for offering to arrange transportation for me from Boston to the Cape for the reunion, but I am afraid I will miss it this year. This is the first one I have missed since the five-year one and I had looked forward to it with pleasure.

"I batted my brains out for four years at Tech, later spent all my Saturdays and Sundays afternoons doing homework for night school courses at Penn, leading to an M.S. in M.E. then acquired a registration. With a number of years of experience, my salary is less than a laborer. In the past I have financed these expeditions, plus trips to Europe, South Africa, India, and elsewhere with profits on stocks; this time there ain't none. And I want to go to South America to see the Mallets for which I designed the boilers. So I guess we will have to wait until 1979, and hope to see you all then. "When I was at Tech, the only outfits, building or otherwise, working on railroads were private corporations; government was and has since been building highways, dredging the Mississippi and Ohio Rivers, and providing the free use thereof, building airports and otherwise injuring railroads. I became a very capitalistic, anti-government, anti-Roosevelt, Goldwater Republican.

"Even so, I had the best job any member of our class ever had, thirty years ago: I was working on locomotive design. And it is one of my boilers that I want to see in South America. A few years ago I made the motive power calculations for the Black Mesa and Lake Powell, which led to the selection of which of four routes to use. The final calculations were on the GE computer, but I had a bit of fun on the earlier runs. And I had some fun on the Dulles Airport rapid transit line (which has not been built) and on revised track layouts for the New Haven stations between New York and New Haven. "So maybe I can't kick; the fellows who got the dough never designed a locomotive. And don't forget that the purpose for which God created mankind was to design and build steam locomotives.

"Hope to see you in '79, maybe in Bermuda by ship."

I am sorry to have to report the loss of two more members of the class. **J. Stirling White**, of Sharpsville, Pennsylvania, died May 10, and **Robert E. Mann** of Randolph, Massachusetts passed away on June 9. The latter was somewhat of a shock as Bob had gone to high school with my wife. He is survived by his wife Irene, four daughters and a son. To both families I would express sympathy on behalf of all our class.

In May, **Ralph Marrotta** wrote from St. Louis about his impending retirement. He said "I'm retiring this year after 38½ years with Monsanto Co. in research and am the author of 24 U.S. patents, plus foreign ones. Have just returned from Baltimore where my son Kenny received his Ph.D. from Johns Hopkins University—he will teach English at the University of Virginia starting next fall. (He is Harvard '70, magna cum laude.) My daughter Joanne is a graduate student at Northwest University and my little daughter Linda is a 10th grader at Ladue High School. My wife Rose has been quite an inspiration for the family.

"For kicks I'm presently President of the Greater St. Louis Rose Society, with a membership of 215. Best regards to all my former classmates at M.I.T." Ralph comments that this is his first letter with information for the *Review*—now that he's broken the ice, keep it up.

One item that was missed in connection with the reunion was that at the last minute **Frank Baxter** had to drop out. His wife Mary wrote that he had been admitted to the hospital in Worcester with a coronary. I haven't heard any more, but having been in this same situation I am taking no news as good news, and hope that Frank is well on his way to being back on his feet by now.

I have several comments and notes that came along with Alumni Fund contributions. (Some others plus a letter from Jim Burke I'm saving for next issue.) One really belongs with the reunion news as it came from **Carl Wilson** who should have won any distance prize as he is now located in London—but managed to find some reason that brought him back to the U.S. at the right time. Carl wrote: "Spending a few years here, setting up a marketing operation for Foster Grant sunglasses and polarizing material in Europe. Remarried a year ago to Mollie Jacobson, after a year as a widower. Together, this has been an extremely exciting and rewarding experience. Life in London is not quite as bleak as reported in the press."

Suffering from almost an excess of forebearance **Bill Coleman** says "Still working in research for U.S. Steel" There's not a lot of room on those envelopes, but please, Bill, next time a little more . . . **Bob Ebenbach** writes; "Have had two trips to Tokyo recently, witnessing structural tests on car bodies for new light rail vehicles (trolley cars) for Boston and San Francisco. Vehicle bodies and trucks being built there for the prime contractor, Boeing—Vertol of Philadelphia; I'm acting as part of the L.T. Klauder Consulting Team for the purchasers."

The last one should be included now before the recent positions arrogated by the press are forgotten. From **Harold A. Butters, Jr.**: "The *Review* being part of the media I have nothing newsworthy to report. I am not being subpoenaed, investigated, or even suspected of kidnapping. Is it news that a man is healthy, has two lovely daughters and four adorable grandchildren?" No Harry, it's not news but it sounds like a highly enjoyable situation. But if you want to go out and bite a dog—then we can really give you coverage!

If I may conclude with some personal items, we have devoted a fair amount of time this past summer going to weddings of **Eric Isbister**'s sons. The first was June 22 when Eric Duncan, the second son, was married on Long Island. He has one more year to go at Worcester Poly where he has been following in his father's footsteps as an outstanding wrestler. A month later, we were in Charlottesville, Virginia for the marriage of James Iain, the oldest, and our godson. Eric and Mora's daughter, Mora Jean, is studying home economics at V.P.I. but after this summer, Eric says he's had it. He's just

going to leave a ladder outside her room. . . . (Note to **Frank Moore**—from Charlottesville we went over the mountains to the Cass Scenic RR, complete with Shay locos. Then a week later we were riding the 12 miles of the Wolfeboro, N.H. RR). . . . Finally, the first week-end in August we were at Mt. Holyoke for the Massachusetts Audubon Focus Outdoors" nature college" and ran into **Bill Hall** and his wife Ruth. As you may know, he is still curator of the Naval Architecture Museum and was one of our reunioners. —**Robert M. Franklin**, Secretary, Satucket Road, Brewster, Mass. 02631; **George G. Bull**, Assistant Secretary, 4961 Allan Road, Washington, D.C. 20016

35

From the green mountains of Vermont comes a nice letter from our friend and past Class President **Walter Stockmayer**. He reminds us that Sylvia Stockmayer was League of Women Voters State President in Vermont for the three years, 1968-71. Since then she has been appointed by the Governor to a special commission on electrical energy in our state. They have finished their report, but it looks as though election politics may delay its appearance.

"I haven't written you for over a year now. From a class point of view, the main news is that I saw both **Dave Buckwalter** and **Leo Epstein** in Los Angeles at the beginning of April. It was the first time Buck and I had seen each other since 1936, and was due directly to the fact that you had printed the Pasadena address where he and Jean now live. The man looks in great shape, and is busy with the big engineering firm of Parsons. We didn't have any chance to try out his baritone and see if it can still bust the glassware when he lets it go. Anyhow, several nights after dining with Buck and Jean, I met Leo Epstein for dinner. By coincidence, he was out there for a meeting of the American Society of Nuclear Engineers during the same period when I was at the American Chemical Society meeting. Leo is now (since about five years ago and after a long career with G.E.) at the Argonne National Lab in Chicago. His specialty is the cooling systems of nuclear reactors and he is one of the World's experts on the properties of liquid sodium. He and Selma have adopted two nice Korean kids.

"I guess that about covers the people I have actually seen. I sure am looking forward to 1975. The Buckwalters have promised to come; and Sylvia and I want to make up for missing the one in '70, too. Last summer I had a great time as a professor at the French Summer School of Theoretical Physics in Les Houches, just down the road a piece from Chamonix and on a hillside in full view of Mont Blanc. It was rather a demanding session, so the amount of climbing I did was not so great; but I did get up one of those spire-like Aiguilles with a guide. After that Sylvia and I went up through parts of Switzerland, Germany, Holland and back to a meeting in Hamburg, thence for a few days to see friends in England before roaring back home in time for Dartmouth's fall term.

"I've become Chemistry Department Chairman again for a 3-year term but am not overwhelmed in this endeavor. Teaching and research are tied for first place in my affections. We spent a few days skiing at Alta and Park City, Utah, before a Los Angeles meeting where I received the Peter Debye Award in Physical Chemistry from the American Chemical Society. I think I have discovered the reason for this: the presentation was made on April Fool's Day! I have finally stopped doing a chapter in the A.M.C. White Mt. Guide after over 20 years. The hills are now *really* over-run by hikers but I pick my times and still find some fun in them, winter and summer. I'm still playing the piano—did a chamber music recital (2 quartets) last July. Not much singing anymore." Stocky, Sylvia and I sang for a few years with the Wayland Community Chorus and had a great time. I gave up singing in the church choir a year ago after 50 years, since I was a boy soprano. The high point of my choir career was singing Maillot's "The Lord's Prayer" about three years ago. I still have fun with the piano but my twin sons, now 19, are carrying the ball on other instruments: Peter plays clarinet, bass clarinet and the lead guitar and sings in a rock group; Chris plays trumpet, baritone, bass violin, and base guitar in the same group—sings too. My golf has had to be set aside just as my game was going well because kidney-stone surgery in mid-July.

It was good to see the following at the lunch on Alumni Day: Jane and **Peter Grant**, Barbara and **Dick Shaw**, and Helen and **Sam Brown**. The big news for golfers: Helen Brown made her first hole-in-one on the 4th hole of the Doral White course in February. Both Dick Shaw and Sam Brown are involved in the 14th year of our class golf tournament along with fourteen others. Dick is back after a ten-year gap, as is **Hal Bemis** who was one of the first cup winners. One of our golfers, **Fran Muldowney**, a former class secretary, has retired after 30 years as Director of Buildings for the Brookline School Department. He and Dorothy are now settling down at their Cape Cod home, 215 Halyard Lane, New Seabury (mail: P.O. Box 712, Popponesset Beach, Mass. 02560) Tel (617)477-1768. They have six grandchildren, three with married son Francis III at Mather Air Force Base in Sacramento and three with daughter Susan Bullock living in Duxbury.

Dick Bailey writes that he has switched from treasurer to public relations and advertising "where I am learning something new and enjoying it so far. Doing more travelling—more freedom. It has been a lot of work but fun. Just came off of a great week's vacation at Litchfield Beach, S.C." . . . **Ham Dow** told of playing his son-in-law at Torrey Pines North and getting an 89. Now all can see what interesting notes these become with a few letters, long or short, so haul out a piece of paper and start now. —**Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

36

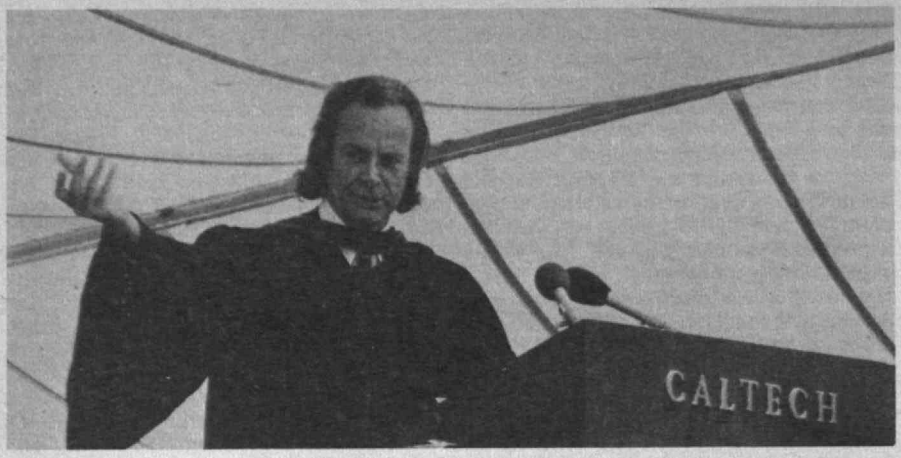
Alan Brigham, **Leo Kramer**, **Roger Krey** and **Ruth Perkins** were officially listed as present at Alumni Day activities. Roger Krey, who was attending for the first time, did not encounter any of the others. Since your secretary was emerging after nine days at the bottom of the Grand Canyon she didn't get to the event and can not verify the list. Roger further comments that he has some attractive lakeside real estate in Mirror Lake, N.H., which would be available for a mini-reunion. How about the fall of '75? . . . More and more class members are joining the "retired" list. **Stephen Richardson** writes that he retired in 1971 as Senior Partner and Director of The Richardson Associates, Architects, Engineers and Planners, of Seattle. He is a Fellow of the American Institute of Architects. . . . **Lawrence G. (Pete) Peterson** retired from General Electric in Schenectady in 1973. He, like me, is finding that there are not enough hours in the day for everything we'd like to do. Having returned from Arizona in early June, I headed west in July for twelve days of backpacking in the Sierra. Our route included Mono Pass (12,000 ft.), the Fourth Recess, Pioneer Basin, Hopkins Basin, Hopkins Pass and out via McGee Creek. I am several pounds lighter and much more muscular. . . . From now on I will be found much closer to home and most happy to hear from all of you.—**Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, Conn. 06091

37

Irving W. Tourtellot wrote that he retired in April of 1974, as a Vice President of Charles T. Main Inc. He and Louise are building a new home on their 75-acre farm in the mountains of western North Carolina and plan to use it as a home base for world travels. **Harvey F. Phipard, Jr.**, reports a new address at 400 Arvida Parkway, Coral Gables, Fla., 33156. . . . **Fred Altman** retired from Computer Science Corp., in April, 1973. In April and May of 1973 he gave papers in London and Rome. . . . **Verne C. Frost** is now working in structural research for the Northrup Corp. . . . **Edward M. Fischer** retired from the Alton Box Board Co., on May 31, 1974. He and Emily left Kansas City to spend the summer at their cabin in Pine, Colo., and plan to return to Kansas City in mid-October. **James D. McLean** writes that he is chairman and President of Patent Development Corp., a Los Angeles communications equipment manufacturer. **Thomas F. Hennessy** is engaged in diversified architectural-industrial design practice. He has been involved in office planning and building and has designed banks and multi media teaching facilities. He is interested in mass transit development.

It is with deep regret that I report the passing of **Quentin Berg**, **James G. Loder** and **Daniel J. O'Connor, Jr.** They were memorialized at the M.I.T. Chapel on Alumni Day Sunday June 2, 1974. We extend our sympathy to their families.

Norman Birch, **Ross E. Black**, **Donald Fenton**, **Louise E. Pepperberg**, **Philip H. Peters**, **Robert H. Thorson** and **William Wold** attended Alumni Day at the Institute. The group had a great time reminiscing about old times. **Robert H. Wolin** has been appointed division vice president, Fossil Power Systems, Power Systems Group, Combustion Engineering, Inc. Mr. Wolin will operate from the Power Systems Group's Windsor, Connecticut headquarters. **Philip H. Peters**, now a Senior Vice President, Group Operations John Hancock Life Insurance Co., was elected President of the Greater Boston Chamber of Commerce. Phil states that an important goal for the Chamber in the year ahead is the development of a cost-benefit analysis as the state



Dr. Richard P. Feynman, '39, addressing Caltech's graduating class last June.

The Dangers of Pseudoscience

Several years of intensive—and pleasurable—effort studying "science that isn't science, theories that don't work" instead of those that do have convinced Richard P. Feynman, '39, Professor of Physics at California Institute of Technology, of the central importance of an unstated principle.

The principle? "A kind of scientific integrity," Dr. Feynman told Caltech's graduating class last June. "A principle of scientific thought that corresponds to . . . utter honesty. . . . The idea is to try to give *all* of the information to help others to judge the value of your contribution—not just the information that leads to judgement in one particular direction or another."

Part of this, said Dr. Feynman, is subtle: "When you have put a lot of ideas together to make an elaborate theory, you want to make sure, when explaining what it fits, that those things it fits are not just the things that gave you the idea for the theory—but that the finished theory makes something else come out right, in addition."

This idea of "utter scientific integrity" is **not** taught in lectures or laboratory work-books, not specifically included in any particular course. "We just hope you've caught on by osmosis," Dr. Feynman admitted in his Commencement address.

Some words of caution to the new graduates: "The first principle is that you must not fool yourself—and you are the easiest person to fool." And young scientists should resist the temptation, too, to fool laymen when talking as scientists; instead, Dr. Feynman said, "bend over backwards to show how you're maybe wrong."

What about "science that isn't science"? People who think a repeatable experiment is an irrelevant one? Extrasensory perception, expanded consciousness, U.F.O.s, astrology, mysticism? It took a week-end at Esalen, said Dr. Feynman ("a wonderful place," he adds), to show him how much nonscience there is in the world. But nonscience is not reserved for such exotic places. We have a system for treating criminals, but even when used most effectively that system has contributed nothing to decreasing the amount of crime. Despite elaborate systems for remedial reading and mathematics teaching, reading scores "keep going down—or hardly going up . . ." We fool ourselves, says Dr. Feynman, into thinking we know more than we really do, or succeed better than we actually can.

Despite "a long history of learning how not to fool ourselves," we are too easily intimidated by pseudoscience, too thoughtless and lazy to be logical, to avoid errors, to think with scientific integrity.—*J.M.*

---

considers its fiscal affairs and legislation.... **Leonard A. Seder** was awarded the 1973 American Society for Quality Control Grant Award "for outstanding leadership in the development and application of meritorious educational program in the field of quality control". Leonard heads the firm of L. A. Seder and Associates, consultants in Quality and Reliability, and the Quality Control Personnel Services, placements specialists in these field. Len was director of the Quality Control Program at Northeastern University for 25 years where he developed and taught many courses. His educational activities have taken him abroad frequently for 12 years to conduct almost 100 seminars for Quality Control and management personnel in 10 European and Middle Eastern Countries.—**Lester M. Klashman**, Assistant Secretary, 198 Maple St., Malden, 02148; **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, Mass. 02155

39

The thirty-fifth Reunion was a success, being held May 31 through June 2 at Bald Peak Colony Club in New Hampshire. Some ladies said the site name fitted the men. Everyone agreed the reunion was a great, relaxing time and we all thank the committee which included **George Beesley**, President, **Aaron White**, Treasurer, **Fred Schaller**, Reunion Chairman, and committee men **Ben Badenoch**, **Dave Bartlett**, **Ernie Kaswell**, **Harold Muckley**, **Seymour Sheinkopf**, **Harold Snow**, **Paul Stanton**, **Oz Stewart**, and **Bob Touzalin**.

For three days there appeared to be four major sports. At tennis some approached exhaustion. At golf some approached par. At outdoor walking some approached the shore. At indoor walking some approached the bar. But no matter what the sport, there was an overall atmosphere of relaxation, with pleasant communications between the many who have had so much in common these last 35 (plus 4) years.

A picture was taken. For your record copy showing the increasing girth, baldness, and wrinkles of your classmates send your check for $4. and your order to **Seymour Sheinkopf**, 205 Wolcott Rd., Chestnut Hill, Mass. 02167.

Those who registered to attend reunion included: Gay and **Ben Badenoch**, **Dave Bartlett**, Mary and **Jim Barton**, Eleanor and **George Beesley**, Lucile and **Bill Brewster**, Marietta and **Wade Caywood**, Erma Ruth and **Harold Chestnut**, Lois and **George Dadakis**, Jean and **Joe Dana**, Lillian and Beatriz and **Orlando DeAragon**, Marie and **Elmer DeTiere**, Alicia and **Lawrie Fabens**, Bernice and **Charles Friedman**, **Esther Garber**, Jean and **Barry Graham**, Lucille and **Jack Herlihy**, Anne and **Ben Howes**, Yolande and **Ernie Kaswell**, Mary and **Martin Lindberg**, Blossom and **Joe Mazur**, **Mort Metzger**, **Dave Morgan**, **Manning Morrill**, Annette and **Sig Oettinger**, Ky and **Arthur Olson**, Viola and **William Phillips**, Nancy and **Gordon Pope**, Betsy and **Bob Sackheim**, Anne and David and Elizabeth and **Fred Schaller**, May Ann and **George Senior**, Hilda and **Hal Seykota**, Sylvia and **Seymour Sheinkopf**, Jean and Paul and **Sid Silber**, Evelyn and Wendy and Tina and Ted and **Bob Thompson**, Mary and **Bud Venable**, **Albert Waters, Jr.**, Arlene and **Irwin Weiss**, Edith and **Aaron White**, Anita and **Bill Wingard**, **Bob Youngquist**

At reunion these new Class Officers were elected: President **Ernie Kaswell**; Vice President **Aaron White**; Vice President **Oz Stewart**; Secretary **Hal Seykota**; Treasurer **Seymour Sheinkopf**; Class Agent **Fred Schaller**; Special Gifts **Manning Morrill**.

For many years **Oz Stewart** has brought each of us pleasure as he has done the Class Notes. Why not write to tell him you appreciate his contributions.

During Sunday Tech Night at the Pops, we are happy to be joined by Dotie and **Bob Casselman**, Ginny and **Fred Grant** and Adie and **Bill Pulver**, all of whom had been especially supporting the Wellesley '39 thirty/fifth reunion.

After returning to Florida, I wrote Don Severance, Executive Vice President of the Alumni Association, for instructions about the Class Notes. Don's answer included the news that he will be undertaking a new assignment in connection with a new program we all will be invited to consider about new capital requirements of the Institute. Also, I received the 1939 printout including names of 724 alumni, between Sam Abbott of New Hampshire and Abe Zimmerman of Connecticut. To get the address of any of your classmates, just write me and enclose a bit of news I can use for the Class Notes. Also I received 13 instructions for writing these notes. The first read: "Don't use no double

negatives." The thirteenth read: "Correct speling is essential." There was no mention about the underlying requirement for classmates to write news bits frequently. What I am trying to say is that I'll follow my 13 rules if you'll follow your one. Incidentally, the *Review* is interested in photographs, so send them along, too. Billie and **George Cremer** have returned from vacations in United Kingdom and Italy. They saw Vesuvius, were impressed by the ruins of Pompeii, and said they made no speeches in the Forum and fought no bulls in the Coliseum.

Aletta and **Bob Touzalin** announced the marriage of their daughter, Ann Stevens, to Thomas Michael Smith, on June 1.—**Hal Seykota**, Secretary, 14650 Island Drive, Jacksonville Beach, Fla. 32250

40

By now you have undoubtedly heard of the death of Vannevar Bush who was Vice President of the Institute while we were there. Your Secretary is a patent lawyer and long before he ever dreamed of going in the patent field he can remember the lectures given by Dr. Bush in our freshman program ending with a requirement that we write a patent claim on a belt. Your Secretary can highly recommend to you Dr. Bush's book *Pieces of the Action* as one of the best autobiographies of this century. . . . **Bill Steber** is Deputy Assistant Secretary for Systems Development and Technology in the Department of Transportation. He has held this post since October, 1971. His responsibilities include scientific and technological research and development advancing transportation capability as to its safety, effectiveness, economy, and viability; technological input to development of transportation policy; abatement of noise generated by transportation equipment; and telecommunications. Prior to his present employment Bill was with Sperry Rand for 19 years and he has also spent time as Missile Systems Chief Engineer of the Columbus Division of North American Rockwell. . . . Some of us are reaching that age. From **Clark Goodman** comes the note that he has recently retired from the University of Houston and is now in full-time consulting in Coronado, Calif. . . . **Bob Hess** writes, "Our big news this year is that our elder son Tom was awarded a Merit Scholarship. He's now a freshman at Princeton majoring in architecture; he hopes to do his graduate work at Tech." . . . Another retiree is **Karl Pfister** from whom comes the following: "Left research and development in the pharmaceutical industry in 1971 after nearly 30 rewarding years with Merck and Co., Inc., in Rahway, N. J. I am now a Corinthian farmer (you yachtsmen know what I mean) here in Vermont. Horses, a few beef cattle, pigs later this month, and so on. If you want to see a lot of your off-spring without having to beg them visit, just retire to a farm in Vermont!" . . . While **J. L. Mahoney** pens: "Retired from Civil Engineer Corps, U.S. Navy. Now working for Ventura County California as Division Engineer in charge of Road Administration Division of Public Works Department." . . . **William Singleton** advises, "Have been in private practice of city planning consulting work since 1952 assisting more than 100 towns, cities, and regions in planning and zoning problems. Colonial Carolina has become my hobby and hope to publish a story of Blackbeard the Pirate soon." . . . And finally from **Rafael J. Martinez**: "Piling up years upon years but still in good shape. Have four boys but no grandchildren yet. Children much smarter than old man, not an engineer in the group!"

It is with regret that I must report the death of **Jim Watkins**. We are indebted to his widow Alice for the following obituary: "**James E. Watkns** of Richmond Avenue died in his home on March 22. A resident of Amityville for 21 years, he was born May 19, 1918, in Massachusetts. Mr. Watkins was an electrical engineer. He is survived by his wife, Alice; a daughter, Janice; 3 sons, Edward, John, and William, all of Amityville; and his mother, Margaret Watkins, of Mass.

The Class of '40 was well represented on Alumni Day, even though this was not a reunion year. Those attending included: **Edgar L. Bernard**, **John L. Danforth**, **Sam Goldblith**, **Herbert J. Hollomon**, **Harold Jaffe** '42, **Kelvin H. Kiely**, **Edward J. Kingsbury**, **Bryce Leggett**, **Stanley Luce**, **Bill McDonald**, **Dick MacPhaul**, **Philip A. Stoddard**, **Barton Weller**, **James Rumsey**, **Jim Baird**.

Among those classmates who were remembered at the memorial service on alumni day were: **Malcolm C. Allen**, Dr. **John H. Daniel**, **Frank E. Plumley** and **A. Ward Wood**.

Write—**Al Guttag**, Secretary, Cushman, Darby and Cushman, 1801 K St. N. W., Washington, D.C. 20006

42

The **Rosetts** were in Israel at the time of the July/August class notes deadline, so after a long lay-off. . . . We were impressed with our visit to Technion which is billed as the "M.I.T. of Israel". Actually, its organization and course structure are very similar to ours but its campus is a lot prettier. Technion has graduated perhaps 95 percent of all of the scientific and engineering people now working in Israel and can be justifiably proud of its contribution to the country's growth.

Gene Hanszen has been commuting to Mexico and India as a consulting engineer specializing in the use of plastics in chemical and fertilizer plants; in India, Gene is consultant to Zuari Agro Chemical, Ltd. More news from India comes by way of a note from **Lou Rosenblum** with a handsome brochure from **Nanu Amin**'s Jyoti Limited. His firm has grown mightily, and it now produces pumps up to 10,560,000 gal./hr. capacity; motors, generators and hydroelectric generating equipment up to 5,000 kw; and electric switch gear up to 220 kv. In addition to its own design of deep-well vertical turbine pumps, Jyoti has developed a line of power-driven agricultural equipment including threshers, power tillers, and harvesters. Currently, Nanu is manufacturing pump sets for handling heavy water at a pressure of 200 atm. and temperature up to 330°C. for atomic power plants. Both Lou and **Paul Hotte** have visited with Amins in Baroda.

Charlie Smith was elected Chairman of the Board of the Chamber of Commerce of the United States last spring. . . . **J. J. Rogers** retired from the U.S. Foreign Service and is now Director of the Bureau of International Commerce of the Commonwealth of Pennsylvania at Harrisburg. . . . **Robert Seamans** was re-elected President of the National Academy of Engineering.

On the local scene, **Harvey Kram** and **Bob Greenes** are out working hard on **Howie Samuels**' campaign for election as the Governor of New York State. . . . **J. J. Quinn** is still flying for Golden West Airlines, and he and Betty were planning to join the **Jerry Coes** for a sailboat cruise from his home port in Connecticut up to watch the 12-meter America's Cup trials at Newport.—**L. K. Rosett**, Class Secretary, 191 Albemarle Road, White Plains, N.Y. 10605

43

News of classmates who have recently retired came pouring in last month, which prompted me to examine my Social Security benefits which will start in 1984. A closer examination of the news items disclosed that these were graduate students who are associated with our class and not the young, virile undergraduate species. No hard feelings, I hope. Thus **Frances Kraft Golden** wrote that she and her husband, Dr. Russ Golden, retired in Laguna Hills, Calif., in 1968, at Leisure World, and have been more active than ever keeping up with the recreational and educational opportunities provided in that location. . . . **William M. Rowe**, who received his master's in meteorology with us, retired after 35 years in the Weather Bureau. . . . **J. Thomas Rogers**, another meteorologist, retired as a foreign service officer with the U.S. Department of State after 27 years of duty and then became the new Director of the Pennsylvania Bureau of International Commerce.

Dick Henning wrote that he retired in February after 31 challenging and satisfying career years in the Navy and has now started on Career Two: He joined **Howie Scott** on February 11, 1974 (after 11 days of retirement) at Bird-Johnson Co. in Walpole, Mass., where Howie is President. Dick's son Richard has finished his second year at the University of Virginia Law School, and his other son, Bruce, was stroke of the M.I.T. Frosh heavies last year. . . . **Malcolm Walker** wrote that he is still with Electric Boat, in nuclear design. Always active in community affairs, Malcolm just completed two years as President of the Braintree (Mass.) Historical Society and is now a director and chairman of its Museum Building Committee. He is a Corporator and Trustee of the Braintree Savings Bank and a member of the Braintree Bicentennial Committee. . . . **Charles J. Lawson** wrote that he sold the vacation home in New Hampshire and is now concentrating under one roof in a new apartment now under construction. We assume this is in the Old Greenwich, Conn., location, and that it is completed by now, Charlie. . . . **Virgilio Barco** was elected Senator of the Republic of Columbia on April 21.—**Richard M. Feingold**, Secretary, 3757 State Street, Santa Barbara, Calif. 93105

46

A problem and disappointment is the poor response I received from a double post card mailing we sent two months ago. One of the

double post cards was already addressed to be returned and asked the classmates to send us a brief report on his recent activities. This mailing was sent to 30 classmates who had not been written about in the notes recently. We have received no returns to this mailing as of now, and I urge those of you who did receive the mailing to please drop us a line.

The Class was represented by five members who attended the 1974 Alumni Day. They were: **John L. Bateman**, **Robert E. Michaud**, **Edward W. Richardson**, **Clifton Sibley** and **Peter S. Wright**.

John High has retired from the U.S. Navy, as a Commander, in 1970 and has begun a new career in the oil industry. John is with Technical Oil Tool Company Division of Baker Oil Tool Company and is working in the area of oil well drilling instrumentation.

Ralph Huschke has left the Rand Corp., after twelve years, and is self-employed as a consulting meteorologist. His main client is still the Rand Corp. in Santa Monica, but he is developing new work in the San Diego area. Ralph reports the freedom and novelty of consulting more than makes up for the fringe benefits of corporate employment. He has just built a new home in Coronado, Calif., right on San Diego Bay, with a boat dock at the back door.

Richard J. Steele has the honor of being selected the only non-physician to receive the American Heart Association's award of merit in 1974. Richard has chaired the Association's policy committee and has been active in the National Volunteer Leadership as well as Vice-President of the National Health Council.

Sterling S. Bushnell has joined the Zimmer Company in Warsaw, Indiana, effective earlier this year. The company is in the orthopedic field as manufacturers of surgical implements, related instruments, and hospital equipment. The Bushnell family was scheduled to move to Warsaw after the June high school graduation. The Bushnells will have only one child (of four) still at school at home.

Ernest G. Jaworski has been promoted to Distinguished Science Fellow at Monsanto Company and elected Chairman of Gordon Research Conference, on plant cell and tissue culture for 1975. Ernest also has been elected to Editorial Board of Plant Physiology Journal.

Shepard M. Arkin has been named to the newly created position of Director-Program Development for Raytheon's Missile Systems Division. Previously, Shepard was manager of the Advanced Systems Center in the division. Shepard joined Raytheon in 1956. Previously he was Technical Director of air launched missiles for the Navy. Shepard received both his B.S. and M.S. degrees at M.I.T., and has received many honors in the 27 years since. He is Vice-Chairmen of the Aerospace Industries' Association, Aerospace Technical Council and an associate fellow in the American Institute of Aeronautics and Astronautics. Shepard and his family will continue to reside in Lexington, Massachusetts

In 1964 **Fred W. Ames** joined the Coast Guard where he now holds the rank of Lieutenant. Fred participated in the largest and most complex international scientific experiments undertaken. Aboard the Coast Guard cutter Dallas, operating out of Dakar, Senegal, he assisted in the collection of data over the tropical Atlantic and adjacent land areas. The data will be used for a study of the behavior of cloud clusters and their role in the larger circulation of the atmosphere. Fred Ames is assigned to the Dallas, which will be the communications center for the 25 ships assembled, along with several aircraft and support from nearly 100 land stations.

Two sad notes. **Calvin M. Newman** of Omaha, Nebraska, died on May 13, 1973. **Robert H. Marks** sadly reports his wife, Dorothy A. Marks passed away suddenly in March, 1974.—**Russ Dostal, Secretary**, 18837 Palm Circle, Cleveland, Ohio 44126

47

Alumni Day was attended by **Harl Aldrich**, **Claude Brenner**, **Cecile Butka**, **Bob Hagopian**, **Raymond Hasse**, **Dick Knight**, **William Page**, **Marty Phillips**, **Arnold Putnam**, **Al Richardson**, **Don VanGreenby** and **John Yocum**. I trust that they enjoyed the day.

Bob Heaton is doing some vocational teaching, consulting engineering and working on the rehabilitation of inner city housing. . . . **John Barrett** has been appointed Assistant Vice President-Buildings and Real Estate by New England Tel & Tel. Dr. **Jerry Cox** has been Director of the Biomedical Computer Lab at Washington University Medical School in St. Louis since 1963. His consulting and lecturing causes him to travel considerably to such places as Russia, Israel, Greece, Rio and Hawaii. The Cox children are now 21, 18 and 8.

Fred Churchley is in Warren, Mich., as Product Manager of Power Flex Products of American Chain and Cable Co. In this capacity he has world wide responsibility for the product line.

Henry Sandler writes that he is entering the years of diminishing returns with two daughters at Harvard. He also points out that he is probably the only person in Philadelphia who didn't see the Flyers. Henry, you've made a mistake.

Ben Craig has been back in his hometown of Florence, Ala., since 1950 raising his harem. One of his six daughters is now married. He eventually should be the class expert in weddings and receptions. In a business way, he is President of the B. H. Craig Construction Co. and recently has been President of the Birmingham Branch of the Associated General Contractors. He is also an elder in the Presbyterian Church and an Advisory Board member of the Central Bank of Alabama.

Willis Reals has been elected Vice President in charge of the Strategic Planning Dept. of Texaco. In this period of energy confusion Willis should certainly face a challenge.

In a much lighter vein, **Al Richardson** was in Ohio in July visiting his sister so he came by to play golf in a stag day at the club. He played very well winning the prize for second gross but I didn't realize that I had invited the 1974 version of the "man who came to dinner." Leaving the club after dinner, Al's car wouldn't start so he went home with me to tackle the problem in the morning. Replacing a starter on the fourth of July is not the easiest project but Al finally got the job done about 2:00 p.m. As he left I commented that If one had to have trouble while on the road it was nice to have access to a country club, a home and an extra car.

We recently spent two enjoyable weeks at Kitty Hawk with Chuck Holmes, '49 and his family up from Atlanta. Chuck started with our class and was an old roommate of mine in New York. Drop a line.—**Dick O'Donnell**, Secretary, 28516 Lincoln, Bay Village, Ohio 44140

49

After many months of construction, I finally have my own desk and office, here in Rio. From my window, I look directly up at Corcovado, the humpbacked mountain, with its world-famous statue of Christ, The Redeemer. It is a clear early-August winter day in Rio, with three leaves blowing in a moderate wind, and with temperature in the 70s. I found it hard to recapture the feel of our 25th Reunion, now over two months and 1300 air travel miles in the past.

Registered at the Reunion were 82 classmates (plus 14 more who showed up on Monday for Alumni Day). Also very much present were 63 spouses or friends and an uncounted number of children, ranging in age from very young to the early twenties. Most everybody seemed busy.

Except for an unaccountable delay in the arrival of beer for the official class meeting, and a slight drought at the bar, early one morning (or late one night, as you prefer) the planning and performance of the logistics associated with the weekend, was superb, thanks to the dedication and hard work of the Committee, under the joint leadership of our ex- and current Class Presidents, **Stan Margolin** and **Paul Weamer**.

At the formal class meeting on Monday, Stan took the opportunity to pay tribute to **Bill Edgerly**, for his work as President of the Alumni Association, and to **Len Newton**, Chairman of the Class Gift, for his persistent dedication, and final success in achieving the half-million dollars required to fund the 1949 visiting professorship. Stan also announced that Alumni Day and our annual class cocktail-party will fall on Friday instead of Monday, starting next year.

A slate of three class officers was proposed and elected as follows: **Paul Weamer**, President; **Harry Lambe**, Vice-President and Treasurer, and **Frank Hulswit**, Secretary. It was also moved and passed that the class officers be empowered to appoint other officers, as needed, during the five-year tour-of-duty. There was a discussion, but no decision, on the location of future class reunions. **Paul Weamer** assumed control of the meeting and adjourned it, after proposing a vote of thanks to **Stan Margolin** for his active and dedicated five years as President.

On Monday evening, after a reception at President Wiesner's home, the official class dinner-dance was held in Walker Memorial, our first class function there since the junior ball in 1948, after which the class was banned from further social activities on campus. **Stan Margolin** presented electronic beavers and drunken-beaver mugs to a number of classmates and friends of the class. Since we have many news notes this month, and since I want Stan to review my reunion notes for accuracy, I will complete my report on the 25th Reunion in the next issue of *Technology Review*.

A Record on the Way to Bermuda for an M.I.T. Man of the Sea

Ondine IV is a 70-foot, 40-ton "even stephen" ketch—which means that her main and mizzen masts are identical (85 ft.) in height. Her design is by Britton Chance, Jr., starting in the fall of 1972; she was launched last winter, sailed the winter circuit in Florida, and then proved herself when she carried her skipper, Sumner A. ("Huey") Long, '47, and his crew first across the finish line in the Newport-to-Bermuda race this June. Her time for the 635 miles was 20 hours and a few minutes—an average of better than nine knots, faster than any boat in the history of the classic.

Speculating on just such an outcome, John J. McNamara, Jr., wrote in *Sail* last winter that *Ondine IV* could have the same effect on large racing boat design as did the unconventional shape of *Cascade,* built for Jerome H. Milgram, '61, in the 1960s.

Ondine's owner has been a man of the sea since before coming to M.I.T. to study naval architecture. He put himself through the Institute by serving as a "ship's husband" to vessels lying in Boston Harbor, and he has been in ship brokerage ever since—mostly for the firm of Long, Quinn, and McAleer, of which he is president.

His day is spent in hectic negotiations with ship owners and users; in the evening he retreats to a comfortable life which—as Mr. McNamara describes it—would not be inappropriate for a Hugh Hefner hero. But on weekends all that changes, and Mr. Long becomes an adroit, shrewd, and compulsive competitor. "He cares for one thing: to finish first," wrote Mr. McNamara. "His precision in celestial navigation and overall tactical-strategic judgment rank with the best, . . . and he is among the last to reef and the first to crack on canvas."

The result is a collection of trophies, which Mr. McNamara suspects is unequalled on the globe, inscribed to Mr. Long's several *Ondines*—Transatlantic, Newport to Cork, Newport to Bermuda, Buenos Aires to Rio de Janeiro, Transpacific, San Diego to Acapulco, Sidney to Hobart . . .

Clockwise from top: the Ondine IV; her skipper, Sumner A. "Huey" Long (left) receiving the winner's trophy from His Excellency Sir Edwin Leather, Governor of Bermuda (right), Lt. Colonel James D. Conyers, Secretary of the Royal Bermuda Yacht Club, is in the middle; champagne for the crew. Bermuda News Bureau photos.

Starting off with Technology-Fund notes, as usual, we have the following: **John Alger** reports "My son Mort has been admitted to the class of 1978, and will start this fall (1974). This is my second in private colleges. I'm feeling old and broke, but ILLIGITIMI NON CARBORUNDUM!" . . . From **Leonard Bezark Jr.** "After 25 years in the medical industry (the last few as President of the Medical Supply Division of Litton Industries), last year I joined two colleagues to start American Radiologic Systems, Inc., to design and manufacture medical x-ray apparatus." . . . **James Critser** is now President of Lexington Data, Inc., an organization that publishes reports of U.S. patents in the chemical field and performs special patent searches. . . . **Robert Griggs**, from San Juan, Puerto Rico, says: "oldest daughter Linda, getting married June 1 to William J. Swedish, who has an M.S. in aeronautical engineering from M.I.T., in the early 70s. This is delaying the arrival until Sunday at the 25th Reunion of Jay, myself and our three kids, but it's worth it!" . . . From **Gerald Grott**, a technical note, "Presented a paper titled "Single Stage Conversion of Unprocessed Automobile and Appliance Scrap Into Refined Steel" at the Symposium on Waste Metal Reclamation presented by the Department of Interior, in Chicago on May 7 and 8, 1974." . . . **David Hardin** writes "It is a pleasure to report that I was ordained as a Minister in the Episcopal Church on January 12, 1974, after three years of study at Seabury Western Theological Seminary, on the Northwestern University Campus." . . . **Ray Homan** rhapsodises, "Raising our four children sanely demands most of our energy and skill. We are still reliving enjoyably the memories of last summer's Homan family camping trek across Western Europe. Two glorious months of avoiding tourist traps, fellow American tourists, and crowded cities through Luxembourg, Spain, Portugal, Andorra, Switzerland, Lichtenstein, et al. Ah, the life of the vagabond!" **William Hutchinson, Jr.** "Presented a paper on the Sanitary Performance of High-Water-Table Landfills for Solid Waste Disposal to the Environmental Chemistry Section of the American Chemical Society at the Florida State Meeting in Tallahasee, on Friday, May 10th, 1974." . . . **Robert King** notes that the Annual Montreal vs. N. England Senior Tennis Tournament takes him to Montreal June 1-2. He missed the 25th Reunion as a result, but sends greetings to his classmates. **R. Kraeuter** reports "My 13th year with New York Port Authority. Enjoying work on computerized traffic control systems, parking revenue control systems, tolls revenue control systems and vehicle identification systems." . . . **Terrell Marshall, Jr.** breaks "25 years of silence" with the following: "Spent 12 years in various engineering functions with General Electric Co.; taught 10 years at University of Pennsylvania in Philadelphia and received

Ph.D.; now Professor at Spring Garden College, also in Philadelphia. Beautiful, talented and loving wife is full-time student in Penn Nursing School. Have 8 children, including Joseph, the most affectionate, wisest, kindest 4½-year-old imaginable. Joseph saved the day three times on a trip west last summer: rescued his father from an anthill, discovered missing gas cap, closed and latched camper door at high speed. Would like Joseph to see his name in print."... **Fred Reusswig** reported in May: "Mary and I are looking forward to attending Class of 49, 25th Reunion. Saw Harl Aldrich last spring, and enjoyed his tour of Boston complete with running commentary. Stanley Consultants tripled its M.I.T. grads with Virg Minch and Doug Eckhardt joining us during 1973." ... Finally, from **Francis Sullivan**, "Retired from N.A.S.A. 8 March, 1974 where I held position as Director, Guidance Control and Information Systems Division at N.A.S.A. Headquarters Washington, D.C., since June 1965.... **Andy Bigus** sent along an article "Whatever happened to Mutual Funds", published in *Esquire*, which I will hold until next month.... **John Barriger** was an organizer for the Sloan School Conference entitled "Management Amid Scarcity" at the Palmer House in Chicago, on May 10, 1974.... **Edward Dinowitz** was named Manager of Engineering at Instron Corporation in Canton, Mass., as of April 1974. He is responsible for the firm's extensive product design and development activities carried out at its corporate headquarters. His background includes many years of design and management experience in the electronic and electro-mechanical fields, such as the design of digital and analog systems for use in air-to-ground data links, gyro testing, numerical machine control, and automatic checkout. He holds patents on frequency-shift keying devices, methods for analog storage in magnetic cores, and drome tracking and control systems.... **Dr. Louis F. Coffin**, mechanical engineer at the General Electric Research and Development Center, was invited to present the James Clayton Memorial Lecture by the Institution of Mechanical Engineers in London, in April, at the institution's international conference in Sheffield, England. Dr. Coffin was to be the featured speaker at a symposium entitled "Creep and Fatigue at Elevated Temperature Applications." He has also been recommended by Carnegie-Mellon University to receive The Carborundum Company's third Award of Excellence for iron and steel.

That's all for this month. Best wishes to all classmates.—**Frank T. Hulswit**, Secretary, c/o Arthur D. Little, Acorn Park, Cambridge, Mass. 02140

Members of the Class of 1949 in the garden of the President's House at their reunion.

50

In March of 1974, after 11 years with the Department of Defense (most recently deputy Director of Defense Research and Engineering), **Herbert D. Bennington** joined MITRE Corporation as a vice president of Washington Operations. . . . **Raymond N. Blair** reports that for the past year he has been Editor of Publications, American Newspaper Publishers Association Research Institute, as well as pursuing his own information services activities. . . . When Northrop Airport Development Corporation, where **Fletcher Bartholomew** was responsible for environmental factors, went out of business, he took the position of director, environmental coordination, in the Cleveland Aviation Office of Howard, Needles, Tammen and Bergendoff, where they are performing the Cleveland Jetport Study.

Among those attending Alumni Day were: **Margaret Coleman**, **John Kocher**, **William Maroni**, **Saleem J. Rizk**, **Lester Smith**, **Robert Snedeker** and **John T. Weaver**. **Thomas C. Buchanan**, who has been with Milford Rivet and Machine Co., in Milford Conn., for over 21 years, has been appointed general sales manager of that company. He is responsible for 60 Milford field representatives throughout the U.S. and Canada. He is an acknowledged authority on riveted assembly methods and is the author of numerous articles and papers on rivets and riveting equipment.

Richard E. Dobroth has recently been appointed Executive Vice President of Spaulding and Slye Corp., a Boston-based real estate firm. Prior to joining Spaulding and Slye, Mr. Dobroth had been in professional practice since 1956 with his own architectural firm of Richard E. Dobroth and Associates, Inc. From 1956 to 1973, Mr. Dobroth was also President of Dobroth Construction Co., originating in Chicago, Ill., in 1895. From 1953 to 1956, he was assistant chief architect for the J. G. White Engineering Corp., New York City, where he was responsible for the design and supervision of high-rise buildings, power plants, and commercial buildings. He is a registered architect in Illinois and the Virgin Islands, and a registered real estate broker in Illinois. He is also a member of the American Institute of Architects; the St. Croix Chamber of Commerce; the M.I.T. Club of Chicago; the Sheridan Shore Yacht Club; and previously worked with the Glenview, Illinois Plan Commission for three years.

Eli Goodman, veteran engineer from the AEC's Office of Planning and Analysis, has accepted a two year assignment at IAEA in Vienna in the Division of Nuclear Power and Reactors. Eli was formerly in Tokyo on an AEC assignment and was previously chief of the AEC's Plans and Forecasts Branch. His career in the nuclear industry began in 1951 at Brookhaven in nuclear fuel reprocessing development. He was also the first chairman of the Pittsburgh ANS Section.

John Millios Thomas reports that after military service in the U.S.A.F., he devoted the subsequent eight years to sales engineering and ultimately sales management for a manufacturer of heating, ventilating and air conditioning equipment. He spent the next seven years with the New York Stock Exchange as a partner of a member firm, whereupon he sold his partnership and membership with the stock exchange and relocated to Palm Beach, Fla. In 1970 John was invited into a partnership with Kirk and Company, whose senior partner is the former Governor Claude R. Kirk, Jr., of Florida.

Allen I. Swartz of Malden, Mass., and his son, Mitchell, M.I.T. '70, were judges for the Massachusetts State Science Fair at M.I.T. this spring; he thinks they were probably the only father-son team among the judges this

year. A few years ago, Allen offered his services to the *Boston Globe* and he has been invited to participate ever since. He thinks the quality of work showing at the Science Fair has been going down in the 25 years he's been watching; there are still a few very good exhibits each year, but there are fewer exhibits and more mundane ones. Also, Allen thinks people have drifted away from science and engineering and, today's student, instead of making a device he may need for a project, buys it ready made. —**John T. McKenna**, Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

51

Robert D. Swift, Field Engineer for Pratt and Whitney, manufacturer of aircraft engines, and father of five sons has for the past three years been operating Black Mountain Ranch Resort at McCoy, Colo., north of Vail with a view to retiring from engineering in a few years and living at the resort full time. Nice way to retire! . . . **Howard E. Simmons, Jr.** has been promoted by E. I. duPont de Nemours Co. at Delaware to Director of Research for the firm's Central Research Department. . . . **Paul L. McGill** is now Regional Central Sales Vice President for C-E Power Systems Group of Combustion Engineering, Inc. His home is in Barrington, Ill. Formerly he was manager of nuclear proposal engineering and nuclear products manager. . . . Others joining the ranks of vice presidents are **Ara Shrestinian**, who has been named Vice President in charge of testing and inspection services by Thompson and Lichtner Co., Inc. of Boston . . . and **Christian L. Rust** Vice President for Administration of Booz Allen & Hamilton in Bethesda, Md. . . . also buying a new home in Virginia.

Merton C. Flemings is now assistant director of the Center for Materials Science and Engineering at M.I.T. Dr. Flemings is ABEX Professor of Metallurgy and has been on the M.I.T. faculty since 1956. . . . **David V. Ragone** has been elected a director of Sprague Electric Co. to succeed Jerome Weisner who had resigned due to the press of other duties. Dr. Ragone also serves on the Technical Advisory Board of the U.S. Department of Commerce. He serves on the Board of Trustees of Charles F. Kettering Foundation; on the Board of Directors of Steam Engine Systems Co., Boston; and is chairman of the Advisory Committee on Advanced Automotive Power Systems of the Council on Environmental Quality.

We regret having to report the death of **Glenn A. Eichensee**, 66 Windmill Lane, Arlington, Mass. 02174.

Robert C. Lewis has chosen to devote full time as a Christian Science practitioner in Wellesley. He is also Chaplain Lt. Colonel in the Air Force Reserve. . . . **Milton R. Neuman**, with wife Marilyn, and four children, ages 3 thru 20, has retired and moved to San Diego for health reasons.

Allen B. Ronda reports that he is Director of Planning for David O. Chase Design, Inc. in Skaneateles, N.Y. . . . **Bert E. Eakin** is Director of Research at P-V-T, Inc. in Houston, a lab engaged in thermodynamic and physical properties research for the petroleum and chemical industries. He earned his Ph.D. at Illinois Institute of Technology. Camping and canoeing with Boy Scouts take up some of his leisure time.—**Fred W. Weitz**, Secretary, 4800 S. W. 47th Street, Des Moines, Iowa, 50321; **Samuel Rubinovitz**, Assistant Secretary, 3 Bowser Rd., Lexington, Mass. 02137; **John Dowds**, Assistant Secretary, 1800 N. W. 18th St., Oklahoma City, Ok. 73106; **Marshall Alper**, Assistant Secretary, 1130 Coronet Ave., Pasadena, Calif. 91107

52

After a long news drought, we have a number of items regarding activities of our classmates. . . . **Frank T. Wheby** announces the opening of his office in Evanston, Ill., for the practice of engineering geology and civil engineering. . . . **Howard H. Fawcett, Jr.** is now Manager, Facility planning, Offshore Power Systems Corp, 8000 Arlington Expressway, Jacksonville, Fla. . . . A letter from **George Robert Roy** says that he has survived recent surgery in good shape and is about to join Wilbur Smith and Associates, transportation consultants. He will direct a 12-14 month transportation study of the Metropolitan area of Lagos, Nigeria.

Jim Davidson heads up his own company, James W. Davidson Company, Inc., management consultants, on Park Avenue in New York. His company is a general management consulting firm which helps companies improve the profitability of their operating business units and achieve earnings growth. Jim's background has been as an industrial engineer and facilities planner with Ford Motor Co. and as a trouble shooter for Curtis-Wright, C.B.S. and Raytheon. He has also directed budgeting and operations analysis for the Univac Division of Sperry Rand. He has been in the management consulting business as an officer and owner since 1965.

A news release from the Continental Can Co. indicates that **Jess L. Belser** has been elected a group vice president and general manager of the company's forest products operations. Jess has served since 1971 as Vice President and General Manager of the forest products group's Fibre Drum Division, and last year was named to the position of General Manager of the Corrugated Container Division. He has completed the Harvard University Graduate School of Business Advanced Management Program. He resides with his wife, Charlotte, and their four children in Greens Farms, Conn. . . . Corning Glass Works, Corning, N.Y., has announced that **Rodney I. Frost** has been named Technical Manager of the company's automotive emission control project. Rodney joined Corning in 1952 and served in several engineering positions. He was named an engineering associate in 1972 in the Technical Staffs Division.

The founding meeting of the M.I.T. Club of Switzerland was held February 4 in Lausanne with approximately 25 enthusiastic alumni attending. **Oscar Kaalstad** of our Class was elected Club President. The Alumni Day 1974 attendees of the Class of 1952 were **Newton Shanbrom** and **Leonard Wilk**.

Dan Lufkin retired from the air force in January, 1973, and writes that he has hung out his shingles as a consultant on environmental and computer problems. He is involved in the use of large computer-based information systems in public administration, especially in the legal and ethical aspects of the protection of personal privacy in data banks. He has served on the staff of H.E.W. Advisory Committee on Automated Personal Data Systems and is presently working on a book on international computer/privacy affairs. . . . Captain **C. J. Mathews**, U.S. Navy, writes that he was promoted to rank of Captain last year and is now assigned to the staff, Commander Pacific Naval Air Force, as its civil engineer. He is in charge of a small staff that plans and programs facilities construction and major repair funds for 15 naval air stations on the west coast and in the Pacific Ocean area. His home location is at the Naval Air Station, North Island in San Diego. . . . **Charles H. Beckmann** writes that he is still in the U.S.A.F., now as Chief of Cardiology at Wilford Hall U.S.A.F. Medical Center in San Antonio. He is also working at the University of Texas at San Antonio as Clinical Associate Professor Medicine teaching physical diagnosis to freshman medical students.

James R. Reese, previously President of the U.S. Brass Corp., subsidiary of Hydrometals, Inc., Dallas, Texas, was recently promoted to Executive Vice President of Hydrometals, Inc. . . . After 20 years with the same firm, **Dick Baker** writes that he has now taken his second job since graduation with the Ingersoll Milling Machine Co., builders of special machine tools and extra large milling machines. . . . **Theodore M. Parsons** became an account executive with Merrill-Lynch in Miami at the beginning of 1973. . . . After eight years with Gleason Works in Rochester, N.Y., **William T. Whittington** spent 11 years as Technical Director for Sterling Foundry, Wellington, Ohio. Last spring, he switched to become Technical Director for Valley Mould and Iron Co., (Division of Microdot Industries) in Hubbard, Ohio near Youngstown. Bill writes that his new home, an early Western Reserve style house which he is fixing up, is in Poland, Ohio. . . . **Alfred C. Haacke**, formerly Senior Research Scientist for Taylor Instrument Co., until 1970, is now the Assistant Director, Division of Applied Science at the Rochester Institute of Technology. Alfred is married and has four children. He writes that he would like to hear from old classmates. . . . **Robert H. Damon** sent a note bringing us up to date on his family activities. He and his 15 year old son, Phil, took a one week trip to Austria with a St. Louis Y.M.C.A. group tour in October, 1973. The trip exceeded all expectations and was really a fine experience. His daughter, Leigh, 18, is a freshman (freshperson?) at Vanderbilt University. His wife, Bobbie (Wellesley 1951), is in the second year of teaching inner city first grade. Bob says she really loves it. His other two children are ages 14 and 11.—**Richard F. Lacey**, Assistant Secretary, 2340 Cowper St., Palo Alto, Calif. 94301; **Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, Mass. 01741

53

Dear 1953ers: Since so few letters have rolled in from you people, I can only assume that the obituary columns are full or that you have (virtually) all broken your writing hands. . . . Did get a spark out of **Bill Gouse**, whom I earlier noted was handling two posts within the Department of Interior. His

reply noted that he will be Acting Director of Coal Research only until (and if) Congress creates the Energy Research and Development Administration. (I saw him recently, and he has the least harried look of any bureaucrat I know.) . . . I just received notice from M.I.T. that two classmates passed away during the past year: **Haig Marzbanian** and **Vahan Terzian**. Should any of you know either of them and care to drop me a line about them, I will be happy to carry through. . . . **Fred Brecher** recently was promoted to associate in the firm of Geddes, Brecher, Qualls and Cunningham; 'tis good news Fred. . . . **Howie Stern** has risen from the "dead file" ranks and reports that he is President and Co-Founder of E.Z.M. (if I can read his scrawl correctly); the firm develops and makes accessories for radiology.(Ed.: Money, too, I hope!) He and Linda have two children, Rachel (6) and Seth (4). . . . **Ben Coe** and family moved in Watertown, N. Y. in October 1973 where he is Executive Director of the Temporary Commission on Tug Hill (Did I read that right?). He adds, "We are charged with studying the future of a 1.34 million acre rural and wilderness area on the east side of Lake Ontario. Our recommendations will be ready about April 1975. It is making a most interesting third career."

Classmates in attendance at the last M.I.T. Alumni Day were: Daniel Brzezenski, John Herweg, Louis Junod, Betty Ann (Ferguson) Lehmann, Patterson Smith, Williard Spring and Ted Taylor. . . . I was pleased to learn that **Tom Faulhaber** was remarried this June (to Susan Playfair); they were married at King's Chapel in Boston. . . . That's all the news from you people, so I'll now bore you with a report on my uncensored activities. At the end of classes in May, I zoomed off to Washington, D. C. for the summer in order to: (1) mend a broken heart; (2) find a new "one"; (3) crank out three long overdue technical papers, plus one "qualitative" (i.e., B.S.) type article for the *New York Times* magazine (which they may or may not publish). My fourth book is still underway (and one year late); the major problem at the moment is that my co-writer (a genuine first-class journalist who will add style, class and organization to my dull prose) has been swamped (who hasn't?) with covering the dear ole impeachment proceedings. C'est la vie! In two weeks—i.e., early August—I am heading to St. Thomas (my third trip there) with a "sick aunt". I expect both of us to recuperate nicely! (But expensively.) As of Labor Day weekend, it's back to school (Carnegie-Mellon University) and classes, all of which I genuinely look forward to. And so on, and so forth. . . . Please write, even a short note.—**Martin Wohl**, Secretary, 1420 Centre Ave. (Apt. 1706), Pittsburgh, Pa. 15219

54

The 20th reunion, scheduled for Bermuda, fizzled for lack of interest in May. As usual, **Dean Jacoby** came thru in the pinch and put together a 20th reunion on campus at M.I.T. Saturday activities included a buffet supper followed by a cruise around Boston Harbor, and on Sunday the class joined the regularly scheduled Alumni Day activities highlighted by an Evening at the Boston Pops. Sorry if the circumstances resulted in your missing it. We'll look forward to seeing you at the 25th in 1979! A somewhat new grouping of class officers resulted from the quinquennial elections. **Wally Boquist** is our new President, Vice Presidents are **Paul Gray** and **Harvey Steinberg**, **Bob Evans** remains as treasurer and **Dave Howes**, assisted by **Chuck Masison** and **Lou Mahoney**, continues to toil in the secretarial slot.

Attendees at one or more of the activities included **Wally Boquist**, **Vic Ellins**, **Paul Gray**, **Dallas Hayes**, **Dave Howes**, **Dean Jacoby**, **Lou Mahoney**, **Chuck Masison**, **John McGann**, **Dick Morley**, **Joe Pennimpede**, **Jim Rude**, **Dom Sama**, **George Schwenk**, **Bob Wagner**, **Bob Warshawer**, **Bill Hartrick**, **Harvey Steinberg**, **Francis LaPlante**, **Bob Rohner**, **Don Marshall**, **Stan Hoff**, and **Joe Blake**.

John Bremer has returned to the New England scene after eight years in Phoenix and six in San Francisco, as Director of Advanced Technology for Honeywell Information Systems in Waltham. John and children Jon (15), Hollie (13), and Ted (11) are looking forward to blue water sailing again. We are sad to hear that John's wife of 19 years, Jane, died very suddenly in October 1973.

Chuck Masison has joined Avid in E. Providence, R.I. as operations manager. Avid is an 8-million-a-year producer of audio-visual equipments and stereo speakers. Chuck is in charge of Design Engineering, Production, Quality Control, Purchasing, Personnel, and the Controller. Chuck's oldest son Dick will be at Michigan State this year.

Sam Losh dropped in on the **Mike Mojdaras** in Bangkok last November only to find that Mike was out sailing and Mike's wife and daughter were back in the states. Mike's mother and sisters were great hostesses reports Sam, who particularly liked the Mojdaras' modern post and beam, teak and glass house designed by Krisda Arunvongse '55. Mike started a company which builds air conditioners and refrigerators and also manufacturers SANOY TV in Thailand. He is also currently building a concrete boat. . . . **George Inada** attended the annual meeting of the President's Committee on Employment of the Handicapped. Attendance at the meeting was by invitation only to those individuals recognized in the field of working with the handicapped. George considers himself to be just another individual who spends some of his own time in helping to overcome some of the problems faced by the handicapped. He feels that Nixon's policy of removing any remaining barriers to federal employment of occupationally qualified handicapped persons would be an excellent policy for private employers to adopt. At Vitro Laboratories, George is with the Systems Analysis Section in the Terrier Systems Dept. He lives with his wife and daughter in Bethesda, Md.

Looking forward to receiving news to keep this an interesting column.—**Dave Howes**, Box 66, Carlisle, Mass. 01741; **Chuck Masison** 76 Spellman Rd., Westwood, Mass. 02090; **Lou Mahoney**, 14 Danby Rd., Stoneham, Mass.

55

Your Class Reunion Committee has been hard at work in the Faculty Club lounge, trying to analyze the returns of the questionnaire mailed to you in June. (Incidentally, we have some caustic remarks to certain class members who have been vocal about the reunion but neglected to return their responses). Over 100 did reply, however, and the largest number—although not a majority—favor Martha's Vineyard. This uncertainty has not led to panic, however; the committee was still deliberating when I left.

A number of interesting responses were received, and the one that inspired me was from Dr. Irriganzo Gauzpache, the famous Latin American surgeon and health food proponent. He suggested a three-day tour of the Faulkland Islands and a steady diet of leechee nuts and paint thinner. He feels that for our Twentieth we should come clean, inside and out.

Jim Eacker has been appointed to work on the development of the Simplex-Northwest area for M.I.T.—an assignment that grows directly out of his consulting firm on property development. . . . **John Morris Dixon**, who recently delivered a lecture at Trinity College in Hartford, Conn., is the Editor of *Progressive Architecture* magazine; before taking his present position he was the Senior Editor of *Architectural Forum*. . . . **Bob Grout** continues to work for Eastman Kodak, where he is involved in supervision, long-range software planning, and software research at the Corporate Headquarters Computer Center in Rochester, N.Y. . . . **Charlie Robertson** is working on advanced coal-fired central station power plants at the General Electric Co. in Evendale, Ohio. He is married, has two boys, and is active in church activities, community affairs, and sailing.—**Allan C. Schell**, Secretary, 19 Wedgemere Ave., Winchester, Mass. 01890

56

Frank Bader writes that he, Nancy and the three children enjoy sailing in Long Island Sound. Frank is general manager of Jelrus Technical Products, manufacturing items for the dental trade. . . . **Malcolm Blotner** is with the research division of Lever Bros. . . . **Philip Lieberman** has been named Professor of Linguistics at Brown. . . . **Louis Martel** has joined the nuclear power division of Electric Power Research Institute in Palo Alto. . . . **Eugene Merfeld** is president of Plaza International Corp., a business and real estate investment company. Presently he is running two clothing stores, Hendin's Hollywood Fashions in Baltimore and Daree, fine dress and gown shop on Newbury Street in Boston. For several years the family has hosted foreign students, the current one being a freshman from Malaysia. . . . **Pemberton Shober, Jr.** is manager of manufacturing engineering for Sweetheart Plastics. . . . **Rosemarie Wahl Synek** had a second child, a son, last winter. Both she and her husband are associated with the University of Texas at Austin.—Cosecretaries: **Bruce B. Bredehoft**, Knollwood Dr., Dover, Mass. 02030; **Mrs. Lloyd Gilson**, 35 Partridge Rd., Lexington, Mass. 02173

57

Carl Hagge has joined the administration at Tech as its first full-time environmental engineer. He will be directing the Institute's conservation program. The press release

covering Carl's appointment provided the following background information: "Hagge has done engineering work related to the space sciences for several organizations and since October, 1970, has been self employed in the field of income property management and as a real estate broker. Hagge was an Alfred P. Sloan scholarship winner while at M.I.T. He was employed at American Science and Engineering, Inc., of Cambridge, in 1970, as an electrical engineer, providing technical support for satellite instrumentation designed and manufactured by the company for the National Aeronautics and Space Administration; at the Smithsonian Astrophysical Observatory, from 1959 to 1970, as project electrical engineer for a meteor research project and engineer in charge of a satellite tracking program engineering group and at Edgerton, Germeshausen and Grier, Inc., in 1957-58 as an engineering assistant. He was a second lieutenant in the U.S. Army Signal Corps from 1958-1959. Hagge's first year's salary at M.I.T. will be paid by a grant from the Union Pacific Foundation. The grant was made to the Institute's Department of Physical Plant to help M.I.T.—and, through M.I.T., other universities—protect and add to their financial resources by finding ways of limiting rising expenditures for energy. M.I.T. put an energy conservation program into effect this school year after conducting a pilot program last summer. Institute officials believe that savings of 20 percent or more are possible with stringent conservation measures."

There was a good article on Ray Stata and his firm, Analog Devices, Inc., in the *Boston Globe* in March. Here is a brief extract: "Analog Devices, Inc., stockholders attending today's annual meeting were treated to an incisive commentary on the state of the electronics industry by company president Ray Stata, but the youthful chief executive took more than an hour before he got to what everybody was really waiting for. How was Analog Devices doing? Turns out they're doing well, thank you. In the first quarter ended February 2 the manufacturer of electronic devices posted net income of $399,443 or 30 cents a share on sales of $6.7 million. This compares with last year's first quarter net of $293,454 or 22 cents a share on sales or $4.55 million. Stata also said that things look good for the rest of the year, too, 'notwithstanding a slowing of the general economy.' He pointed out that Analog's bookings in the first quarter reached a record level of $7.4 million, up from the previous quarter's $6.9 million. So far in the second quarter, bookings are running ahead of the first, and we see no signs that our business level will drop from the $30 million annualized rate, Stata said."

With a partner, **Ted Turk** has opened an office to practice architecture in Houston, Texas. . . . **Ernest Wasserman** just sent us a note to say that he married the former Miss Sybil Ashkin on July 4, 1973. Our congratulations and best wishes. . . . **Bill Walsh** and his family are to Europe again with Mobil. Bill will be a Director of Mobil's affiliate in Germany and responsible for planning and supply. They will be living in the Hamburg area. . . . Another classmate going to Germany is **Howard Resnikoff** who will be at the University of Münster for the academic year 1974/75 as a "Senior U.S. Scientist" awardee of the Alexander von Humboldt Foundation. . . . Among those attending Alumni Day at Tech in June were **Paul Ammann**, **Bill Doughty**, **Charles Holmquest**, **Daniel Hynek**, and **Paul Roberts, Jr.**. . . . **Don Aucamp** is now an associate professor of management science at Southern Illinois University's Edwardville School of Business. Don and his wife are running tennis camps over the summer. . . . **Dominick Fortunato** and his wife, Loreta, are parents of a third child, a boy, born in December of 1973. . . . **Henry Durivage**, his wife and daughter are off to SHAPE headquarters in Belgium. Henry was recently promoted to the rank of Lieutenant Colonel. The Durivage's son will remain in the States; he is a student at the University of Nebraska in Lincoln. . . . Well, that's about all for now. Please give me a call when in New York. Our home telephone is 212-865-1732; at the office, the number is 212-883-4301.—**Fred L. Morefield**, Secretary, Apt. 6A, 285 Riverside Dr., New York, N.Y. 10025

59

Even at this point, only the second of the forty columns that we are to prepare over the next five years, I can appreciate **Art Collias'** comments of how little information or communications flow from all of you. Fortunately, we still have some other resources but - - -!

Other classmates who were back at the Institute on Alumni Day after the reunion activities in Hyannis were **George Bloom** who is with General Electric in Burlington and **Ed Talley** who gives excellent directions on how to get lost in Long Island. **Brad Bates**, now with Ford (the car company) in Detroit, especially enjoyed this year's Alumni Day as he was joined by his father who was attending his 50th Reunion. Other recognized faces were **Oliver Filippi**, **Henry Couch** and fellow Course III-mate, **Scott Latimer**. I know that I missed others so why not drop a short note and. . . .

On the corporate scene, former President and Chief Executive Officer, **Martin Zimmerman**, was elected Vice Chairman of the Board of Telco Marketing Services in Chicago. This news was from the *Wall Street Journal* which indicated that Telco leases health-care equipment. Also from the *Journal*: **Robert Hansen** was elected Group Vice President, Operations, of the cosmetics firm, Avon Products.

From the back of one (!) envelope, **Frank von Hippel**, now with the National Academy of Science, will be at the Center for Environmental Studies at Princeton starting this fall. His book, *Advice and Dissent: Scientists in the Political Arena* (co-authored) will be published by Basic Books, also this fall.

Shmouel Winograd was recently elected to the grade of Fellow in the I.E.E.E. Congratulations. We have your most recent address as I.B.M. Research Center.

In a long letter in response to last month's column, **Hal Laeger** informs all his former Baker House buddies that after Tech he received an MBA at Berkeley and then went into advertising promotion and "sharpening his teeth" at the *Wall Street Journal*, *The National Observer* and *Barron's Weekly*. After a short stint with Savin Business Machines, he started his own firm, Hal Laeger Associates, in New York, with a major focus on sales promotion and advertising. Hal, wife Barbara and two sons, make their home across the river in Englewood, New Jersey.

Now let's see if this class can improve on itself and have at least two letters sent to the Secretary before the next issue.—**Allan Bufferd**, 8 Whitney Road, Newtonville, Mass. 02160

62

Scott W. Allison, **Albert Bottoms**, **John B. Heywood**, **Peter Huntley**, **Stephen G. Kukolich**, **Kenneth A. Rahn**, **Harold B. Shukovsky**, **Jeffrey Steinfeld** and **Richard W. Sullivan** all attended Alumni Day '74. . . . **Michael Kottler** is finishing his opthamology residency at Stanford University in September 1974 and will then go to Vancouver, B.C. for fellowship in glaucoma . . . **Marilyn Wisowaty** was married to Larry Niven on September 6, 1969. . . . **Thomas G. Burns** informs us that after eight years in Europe his return to America resulted in a severe case of cultural shock. Their first six months have found them slowly becoming accustomed to America, but California is going to take a bit longer. He says San Francisco lives up to its reputation as one of the leading provincial cultural centers of the world (emphasis on the word "provincial"). He is still working from "within" as a Senior Project Engineer of Chevron Chemical Co., assessing economics and feasibility of major chemical investment projects. . . . **Michael H. Kaericher**, recent president of the M.I.T. Club of Detroit is moving to Sao Paulo, Brazil for the next 2-3 years where he will be an Assistant Controller for Ford Motor Company. He and his family are looking forward to the move and the "experience in international living". His new address is Ford Brazil, S.A., P.O. Caixa Postal 8610, 01000 Sao Paulo, Sao Paulo, Brazil.

Dr. **Peng C. C. Yang** passed away this year and was included in the Memorial Service for M.I.T. Alumni on Alumni Day, June 2, 1974—**Gerald L. Katell**, 7 Silverbit Lane, Rolling Hills Estates, California 90274

63

July, Tokyo. Your peripatetic Class Secretary recently journeyed to Japan on a combination business-pleasure trip. On the way to Tokyo, and while there I encountered several classmates, and picked up some information about others.

Barbara and I spent the night before our trip in San Francisco with Julia and **Larry Beckreck**. The Beckrecks live in a great old house on a very steep hill in the Marina District. The dining room overlooks that famous bay, and on that evening the fog had come in through the Golden Gate and blanketed the city. Pretty as a picture. Larry works for Woodward-Clyde and Associates, a civil engineering firm, currently quartered in the Transamerica Pyramid. His responsibility is the introduction of computer services at corporate headquarters and the offices of Woodward-Clyde around the country. Julia has been involved in the organization and staffing of a free-unstructured school within the San Francisco public school system.

I don't remember what brought the subject up, but our conversation touched on the disillusionment of the technological elite. During our time at M.I.T., technology was very much on the public's mind, and was looked on to provide solutions for many of the big problems facing the country and the world. We, the budding engineers and managers, were the aspiring leaders of the new technocracy and we were filled with idealism and enthusiasm for our task. Now, 15 years later, we find that our technology has created as many problems as it has solved, and the public is looking for new solutions. Instead of being leaders, our influence is on the wane (as technocrats), and many of us are scrambling to keep afloat professionally. We question our motivations. . . . It was an interesting discussion, and I would very much like to hear from others on this topic.

In Tokyo we looked up H'y and **Gene Sprouse** who I wrote about in the June *Technology Review.* Little did I know at the time that I would be seeing Gene in Tokyo. For the past year Gene has been a visiting professor in the physics department at the University of Tokyo. Sitting over sushi and Kirin Beer our conversation ranged from M.I.T. to city life in Tokyo. With the Sprouses as guides we explored a little of the city. We visited Akihabara—a sort of electronic Tijuana, with street after street of shops showing stereos, televisions, calculators, appliances, and electronic components. Very exciting, but the prices are sky high. The calculators, though Japanese made, were often more expensive in Akihabara than the same calculator in Los Angeles. On another evening we all played pachinko—a Japanese cross between pin ball and slot machines.

The Sprouses passed on the information that **Harold Solomon** is also at the University of Tokyo as a meteorologist studying ocean currents. Harold was summering in the States—a wise decision considering the hot and muggy weather in summer-time Tokyo. He has been in Japan for several years and reads and speaks Japanese. He sold the Sprouses a case of Israeli grapefruit, which is like gold in Japan. . . . **Shingo Nishikawa** is also at the University of Tokyo and works part time for T.R.W. Shingo works on the Japanese space program and is a regular pachinko player.

We also learned that **Carl Dover** got his M.I.T. Ph.D. in France, and is now at Brookhaven National Lab. A new baby, Anna Christine, was added to the Dover family in May 1973. Carl moved into a new house last year and has joined the ranks of lawn caretakers. . . . **Paul Fishbane** is at the University of Virginia, but visited the New York State University at Stony Brook last year. Besides teaching physics Paul taught many Long Island environmentalists about insects and mushrooms.

More observations about my Japan trip. We found many contrasts. An 800 year old Zen Temple atop a hill—beside it a stand selling coke and hot dogs. A traditional Japanese Inn, austere and beautiful with a color TV in every room (a Sony of course.) The nightclubs and Japanese businessmen in the Ginza area, with kimono clad hostesses and barkers luring in prospects; the hustle and bustle of the Shinjuku area, filled with young people, short skirts and long hair, small shops, movies and pachinko parlors. Barbara and I wandered about on our own quite a bit. We found the best buys in Tokyo to be the subways, the telephones and some of the smaller restaurants. There must be one hundred thousand tiny restaurants in the city and they all seem to be busy every evening. We tried sushi, noodle dishes, and yakitori as well as tempura and sukiyaki in some of these small eateries, and we experienced many new taste sensations.

The weather was very bad. June and July are the rainy season in Japan and we had 13 rainy days during our two-week stay. There was a typhoon passing over the islands, and a 6.5 Richter scale earthquake. Visit Japan in the spring or summer if you are going that way.

At the end of our stay we spent a few days in a Japanese inn in the countryside near Mount Fuji. Unfortunately it was too foggy to see the mountain. The inn was just what we pictured a Japanese home to be like. We were treated like kings. The food was exquisite, both in appearance and taste, and the setting was lovely and relaxing. We enjoyed strolling around the carp-filled fish pond and walking in the garden. Communication was difficult—my Japanese vocabulary is limited to a dozen essential words and phrases, and while many Japanese speak English, this inn sees very few American visitors and no one spoke English. Needless to say we became expert at sign language. I recommend a stay at a Japanese inn for any of you visiting that part of the world.

I'll terminate this rambling dissertation here. Cliche´: They say travel is broadening. It's true. The culture of Japan is very different from western culture. We enjoyed our trip.

More next month.—**Mike Bertin**, Secretary, 18022 Gillman St., Irvine, Calif. 92664

64

Greetings from your new Class Secretary. Henceforth and for the next five years, *please send* information to 15 Apple Hill Road, Peabody, Mass., 01960 and please do send some news.

Before we get into current activities and our enjoyable 10th reunion, which, regrettably, most of us missed, the Class wants to take this opportunity to say a special thank you to **Ron Gilman** (and Betsy, too) for 10 years of outstanding effort as class secretary.

Our tenth took place on June 29 at the White Cliffs of Plymouth (Mass). The two dozen or so classmates who attended arrived at various times throughout the day. The Class of '64 Hospitality Suite optimistically contained 10 dozen assorted (delicious) doughnuts and enough ingredients for at least 250 cups of coffee. The morning was spent greeting old friends and making new ones, with just a little tennis and an occasional game of catch mixed in.

After an outdoor lunch of hot dogs, hamburgs, corn, potato salad, beer, soda, and watermelon, we gradually made our way down the 83 rickety steps and long steep hill to the beach at the foot of the cliffs. Hours of volleyball ensued on the oceanfront. Purple hearts to those cliff climbers who kept us in watermelon and liquid refreshments on the beach, especially Barbara and **Mike Monsler**, Peggy and **Denny Hinrichs**, and **Joanne Carpenter**. Later in the afternoon a black jack table was set up in the suite to accommodate the displaced Las Vegas persons among us.

Musical entertainment was provided throughout the evening by a fantastic rock group known as the "OWL". **Dave Saul**, our new Class President, provided the non-musical entertainment with his Class of '64 Tenth Reunion Awards Presentation: A Football to **Mike Monsler** for the world record 13 second run up the hill portion of the cliffs. . . . A First Aid Kit jointly to **Sandy Dennis** (tennis) and **Dave Morrison** (volleyball). . . . A Softball and Bat to **Phil Townsend**, the only one who knew what to do with them. . . . The Tennis Award to **Gary Seligson**, plainly our class' best attending tennis player. . . . The Golf Award to **Ken Olshansky** for walking around with Barb Monsler's clubs. . . . The Cube Game to **Bruce Stevens** for black jack magic as our star dealer. And, finally, a Cute Little Green Thing (miniature stuffed animal) to **George** and Sylvia **Schmidt** for endurance on the dance floor. **Dick Carpenter**, **Denny Hinrichs**, **Mike Monsler**, **Dave Saul**, and **Bob Scott** are to be singled out, thanked, and appreciated for their efforts on behalf of all of us to make the Tenth a good one. In attendance were **Don Alusic**, **Dick** and Joanne **Carpenter**, Norm and **Sandy Davis**, **Roy** and Susan **Dewhirst**, **David Fahrland** and Nancy Valentine, **Ivan** and Delia **Johnson**, **Dennis** and Peggy **Hinrichs**, **Larry Kaldeck** and Linda Lassow, Dick and Mary Kurth, **John** and Louise **Ludutsky**, **Mike** and Barbara **Monsler**, **Mike and Beryl Morrisey**, **Dave** and Cindy **Morrison**, **Jack** and Juta **Moter**, **Robert** and Carroll **Sandel**, **Dave** and Sue **Saul**, **Bob Scott**, **Steve** and Marlene **Schlosser**, **George** and Sylvia **Schmidt**, **Gary** and Amy **Seligson**, **David** and Marlene **Sheena**, **Don** and Linda **Silversmith**, **Bruce** and Gail **Stevens**, **Phil Townsend**, **Robert Weggel**. Corrections, additions, etc., will be gratefully acknowledged in future issues.

In addition to all these goings on, a Class Hero: **Bob Howie**, Course VIII, Burton House. After six years at the M.I.T. Instrumentation Lab (now Draper Labs), Bob moved to Washington, D.C. (Annandale, Virginia) to work for the C.I.A. (yes, Central Intelligence Agency), where he rose to the position of Deputy Chief, Systems Engineering Division. He recently joined Ampex Corp. to become their east coast systems marketing and application engineering representative. Along the way Bob collided with a girl named Sue (from Maine) on a ski slope. They got married and now have two boys, Bobby (six) and Brian (four).

To those of you who expected to see their names and haven't, I say please be patient, tune in next month, and please write.—**Steve Schlosser**, Secretary, 15 Apple Hill Road, Peabody, Mass., 01960

67

Elaine and **Joel Shwimer** have returned to the Boston area after having spent a very pleasant 20 months in Paris where Joel worked for the Société National des Pétroles d'Aquitaine. Joel is now with the Cambridge-based management consulting firm of Technology Management. . . Ted Williams is the Environmental Coordinator with F.R. Harris in Boston. . . . **James Williams**

Once the Chickoring Piano Factory, the block-long building at 791 Tremont Street (top) has become Piano Craft Guild, living/working space for artists. The new interior construction was designed to fit with the old–high ceilings, large spaces, exposed wood beams, brick walls, as in the lobby, (bottom).

A 19th Century Classic Moved Into the 20th Century

An idea . . . a vision . . . has become reality for Robert Gelardin, M.C.P.'66, of Gelardin/Bruner/Cott, Inc. "It grew out of a fantasy of mine," he says, eyes sparkling. A place where you live, he feels, should be malleable, adapting as your needs change, yielding to new arrangements with built-in flexibility.

Would there be a need in Boston for this kind of unconventional living/working space? Artists, especially, might want it. Questionnaires were sent to a sample of the estimated 5,000 specialized households. The answer was a loud yes . . . approval of ideas such as large studio space including oversize doors, loading docks, heavy-duty commercial slop sinks, freight elevators, heavy-duty electrical service with extra electrical outlets (some near the ceilings for spotlights), large windows for natural light, wallboards suitable for tacking. Rents would be divided into low income units (25 per cent), moderate income units (50 per cent) and market rate units (25 per cent).

A massive old building was chosen. Built in 1853 by Jonas Chickering—inventor, cabinetmaker, designer, businessman—to house his piano factory, 791 Tremont Street, was then considered the largest structure in the nation except for the capitol in Washington. It was a classic example of 19th Century mill architecture: five stories high, load-bearing walls, large interior spaces for machinery. After 1930, when the Chickering Piano Factory moved, 791 was used for various commercial laundries and machine shops. But by 1971 the owner was five years behind in taxes and the building was a physical liability to the South End in Boston. It was then that Bob Gelardin and Simeon Bruner began negotiations, which resulted in acquisition of the property and a $3,383,000 loan from the Massachusetts Housing Finance Agency.

Their purpose was to create the unconventional space which their questionnaire described. ". . . We decided from the outset not to be precious, to stick with the character of the building, to maintain its structural and spacial integrity," says Mr. Bruner. Costs were kept at $10.50 per square foot (a minimal budget); the new had to fit with the old in an economical, meaningful way. Hardwood floors, wood beams, columns, brick walls and fireplaces were cleaned and sandblasted. Working drawings formed a contingency-planning architecture—decisions had to be made on the job. Dormers were added to two wings of the building, creating duplex apartments . . . and also solving structural problems in the roof. A flexible kitchen/bathroom core was designed to allow walls to be shifted to accommodate columns.

How does it look now, three years after the first vision? Windows range from large to enormous. No two units (there are 174) look the same . . . ceilings are from 10 to 20 feet in height; apartment size varies greatly—between 500 and 1,740 square feet. Moveable closets allow each tenant to partition—and to rearrange—his space according to his changing needs. There are to be community meeting rooms, exhibit areas, restaurants, galleries and other commercial services related to the arts. A courtyard half the size of a football field contains different textures suitable for gardening, children's play, meditation, performance, and other activities suggested by the tenants.

Gelardin/Bruner/Cott, Inc., calls 791 Tremont Street Piano Craft Guild . . . now living/working space for a community of sculptors, painters, photographers, writers, filmmakers, musicians, graphic designers, theater people, architects, illustrators, a gourmet chef, a dress designer, a quiltmaker, a model, a jeweler, a dancer, a tent and sleeping bag maker. Jonas Chickering would be tickled pink.

---

was recently named Ester and Harold E. Edgerton Assistant Professor of Mechanical Engineering. . . . Adrienne and **Ken Beebe**, residents of Galway, N.Y., have a new family member, Heather Erin, born last November. . . . After a two-year interruption requested by Uncle Sam, **John Ritsko** has finished the work for his Ph.D. in solid state physics from Princeton. The Ritskos have two daughters, Kathy, born in February, 1972, and Amy, born in November, 1973. . . . **Kevin Kinsella** is based in Mexico City as Deputy Director of Latin American operations for Tufts University's Latin American Teaching Fellowships program. . . . **Don Berliner** is in the management science department of General Foods. He also does some freelance writing. . . . **George Nybakken** has received his Ph.D. from the University of Michigan and is now working at Uniroyal Research Center in Middlebury, Conn. . . . **John Fadum** is doing independent studies in physics and mathematics. He is planning to work for N.A.S.A. . . . Bertie and **Larry Galpin** are expecting their first child. Larry is now in manufacturing for Dupont. . . . **Tom McCarthy** is Supervisor of conversational timesharing at Sperry Univac in Roseville, Minn. . . . **Marty Kohn** is a senior resident in emergency medicine at the University of Chicago. In 1975 he will be at Stanford in an electrical engineering Ph.D. program.—**Jim Swanson**, Secretary, 669 Glen Rd., Danville, Calif. 94526

68

Welcome back as we start our seventh year

of literary public service. Remember that almost all our information comes from letters and notes you send in, so without your help there won't be much to read. . . . From faraway Yellowknife, North West Territories, **Charlotte Babicki** has sent a long newsy letter. She is still a computer manuals writer for the territorial government and was recently appointed Regional Vice President of the N.W.T. Public Service Association, which is her labor union. This gives her an opportunity to "put all those industrial management courses to good anti-management use". Concerning the living conditions there, she writes, "I am very fond of living in Yellowknife and see no reason why I should ever want to leave. I even liked it when the temperature was −50 for a week last January; at least I had something to write letters about." Charlotte included news that **Patsy Pollock Farrington** had a daughter, Elizabeth, in March and that **Alexa** and **Peter Sorant** had a son, Christopher, last December. **Linda Stutte** has completed her doctorate in physics from Berkeley and is doing postdoc work for Cal Tech at the National Accelerator Lab where **Shirley Jackson** is also located. Charlotte also wanted to send thanks to Mike Harris who was her immigration sponsor. If you would like an interesting letter with an unusual postmark just write to C. Babicki, Yellowknife, NWT, Canada—she's looking forward to hearing from you. . . . Judy and **Len Mausner** wrote to announce the birth of Matthew Aaron on February 18 with a weight of 9 lb. 2 oz. and who looks "exactly like his dad". Len has finished a doctorate in chemistry and is now on the Princeton faculty for one term. They report the following related item, "By the way, our son Matthew's future roommate at M.I.T. will undoubtedly be Ari David Gerstle, son of Ellen and **Claude Gerstle**. Their son was born only three weeks later than ours on March 7, 1974. Since their dads were roommates at M.I.T., we're sure they'll want to carry on the tradition." . . . We have three other births and a wedding to report this month. . . . **Robert Dixon** reports the birth of a daughter, Melissa Rae on January 2. Bob is now a research engineer with Inland Steel Research Laboratories. . . . Bonnie and **Drew Sunstein** wrote to announce the birth of Amy on March 24. Drew worked at Lincoln Lab and then started his own consulting firm in circuit and/or system design named Circuit and Systems Co. He reports the first year has been good. . . . Chris and **Jay Hellman**'s new addition is named Kim. All three of them moved to Washington, D.C. during the summer, where Jay is with a firm engaged in real estate development, leasing, and management. While they were living in Boston they bought an old townhouse in the South End and completed an extensive renovation. . . . Finally, **Emil Friedman** and Hester Leibowitz were married on June 15. Emil is now a postdoc in the Polymer Science Department at the University of Massachusetts, Amherst, and is looking for a job.

From Houston we hear that **Tom James** has changed jobs from Shell Oil to Shell Pipeline. He adds, "I'm glad I'm on the right end of the oil business." . . . **Tom Wilson** has sold his previous business and is now working on his second enterprise, Phoenix Products, Inc., which manufactures sporting equipment. . . . **Bob Young** works for Educational Communications, Inc. and makes audio-visual films for General Motors, Mack Trucks, and other smaller companies. . . . Dave Kaye reports that **Herb Finger** and his wife, Ilene, visited the East Coast last winter. Herb is still working at N.A.S.A. Ames, but apparently finds time to continue in the fine tradition of his undergraduate days: he is now president of the Northern California Lacrosse Association. . . . In San Francisco, **Alec Bash** prepares environmental review and impact reports for the city. In his spare time he enjoys backpacking, river tripping, and volleyball. . . . **Dave Ilfeld** has finished his internship and is now a resident in internal medicine at Cedars-Sinai Medical Center in Los Angeles. Next year he plans to be at N.I.H. . . . Back in the East Coast, **Richard Fox** has moved to Orlando, Fla., where he is a systems engineer for Westinghouse Computer and Instrumentation Division. . . . Last spring **Bob Phair** completed a 2½ year stint as a mathematician in the Laboratory of Theoretical Biology, National Cancer Institute, N.I.H. He comments, "For scientists in the class, I heartily recommend the N.I.H. as a great place to work." While in the Washington area his wife Judy received an M.A. in American studies from the University of Maryland. They have now moved to Ann Arbor where Bob is working on a Ph.D. in Physiology.

Phil Turner writes that he is working on software development management for the Communications Satellite Project Office at the Space and Missile Systems Organization, Los Angeles A.F.S. He plans to leave the Air Force in January 1976 to find some non-DoD aerospace work. He spends his spare time sky diving, scuba diving, and generally enjoying the California area and his continuing single status. . . . **Gordon Logan** has left the Air Force to enter Wharton. As he says, "back to the books after 5½ years of keeping America free—of what, I'm not sure!" . . . Also rejoining civilian life is **Craig Pynn** who spent four years with the Seabees doing civil engineering. He is back working as an electrical engineer with a very small electronics firm, Zemntel, Inc., which manufactures custom automatic testing systems. He adds, "It's nice to be away from the military bureaucracy and back to the simple life!"

Kaia and **Don Fye** have returned to the Boston area and are living in Wakefield. He received a doctorate in electrical engineering from Brown and is working at Microwave Associates in Burlington. . . . **Jerry Grochow** received a doctorate from the Sloan School in June. He is a Principal of A.M.S. now and is involved in a number of different projects. The firm now has five people from M.I.T. and is looking for more. Louise ('70) has one more year to go in medical school. . . . **Robert Kiburz** has received an M.B.A. from Harvard and is now a Sales Engineer at Data General Corporation in Southboro. . . . Finally, **Dick Munson** reports that he is in his fourth year at S.U.N.Y. Downstate Medical Center in Brooklyn. . . . That's all for this month, looking forward to hearing from you.—**Gail** and **Mike Marcus**, 2207 Reddfield Dr., Falls Church, Va. 22043

69

Please notice the new address at the end of this column. I recently moved from our St. Paul office to our Minneapolis office. If you happen to be in Minneapolis, stop in for a visit and a look at the Twin Cities sky line.

I have received a letter from **Dan Dudgeon** in which Dan writes: "At long last I'm leaving M.I.T. with a doctorate in digital signal processing. I grew a mustache, so my advisor, Professor Oppenheim, decided to let me graduate." After graduation, Dan accepted a position as a digital signal processor on the staff of Bolt, Beranek and Newman. On September 14 of this year Dan married Judy Johnson of Summit, N.J. and Wolfeboro, N.H. . . . **Stephen A. Hill** received his J.D. degree on June 5 of this year after graduating from Case Western Reserve University School of Law where he was an editor of the *Case Western Reserve Law Review*. After taking the Ohio bar examination at the end of July, Steve became associated with Bosworth, Sessions & McCoy, a patent law firm in Cleveland. His wife Betsy has completed her second year of medical school at Case Western Reserv and has another two years of study before receiving her M.D. After his previous experiences in editing the M.I.T. Senior House version of *Pravda*, Steve has sharpened his writing skills to the point where he will have a paper published in the *Trademark Reporter* in the near future. . . . In other news from the legal profession, **David A. Frank** is now a patent attorney for Honeywell Information Systems in Waltham, Mass. . . . **David A. Herrelko**, a captain in the U.S. Air Force, and his wife Jan have been assigned to a tour of duty at U.C.L.A. where Dave will study for his Ph.D. in systems engineering with an emphasis on digital avionics. They will then return to Dayton, Ohio where Dee and **Tom Imrich**, and son Tom, Jr., live. Tom is at the Air Force Flight Dynamics Lab, as is **George Slusher**. . . . In other class news, Dave informs me that: Sandy and **Chuck Sieber**, and daughter Cathy, live in Virginia where both Chuck and Sandy work for the Naval Ship R&D Center in Carderock, Md. . . . **Henry Haller** (to whom Dave lost a case of beer when Henry successfully remained a bachelor through 1973) is employed as an engineer with Westinghouse in Pittsburgh, Pa. . . . and Ellen and **Ron Bagley**, along with son Ross and daughter Melissa Ann, are stationed at Malmstrom A.F.B., Montana. . . . **Samuel F. Leader II** is employed by the First National City Bank in Hong Kong. . . . **Alan Davis** received his Ph.D. in electrical engineering in 1972 from the University of Utah. He then spent one year as professor of computer science in Canada at the University of Waterloo. Alan is now employed as a consultant for Burroughs Corp. He and his wife Jan Watts, who were married in February of 1973, are full-time ski instructors for Park City Ski School. In the summer, they live in La Jolla where Alan plays "computer buff." . . . After two years in Indonesia with Harvard and the World Bank, **Eben Walker** has moved to New York where he is employed by First National City Bank. . . . CDR **Jim Marshall** reported in January of 1974 as a facilities and industrial officer at the Naval Ship Research and Development Center in Bethesda, Md. . . . **Robert G. McGregor** is currently working as an assistant to the facilities engineer for the American community in Kaiserslautern, West Germany. Upon the expiration of his four-year commitment with the armed services, Bob plans

to go into the city management aspect of public sector life. . . . Members of our class who attended Alumni Day '74 included **Melvyn Basan**, **Arthur L. Beals**, **Gary C. Dixon**, **Samuel Jacobs**, **Eugene Mallove**, **Dean Musgrave**, **Irene Maxine Pepperberg** and **Ross P. Wilcox**. . . . **Michael C. Keeley** joined G. E., Tempo, Center for Advanced Studies in September 1973 where Mike is employed as a research economist and is enjoying life in the nation's capital. After going through several drafts of his doctoral dissertation, Mike received his Ph.D. in economics in June of this year from the University of Chicago. . . . **Don Rosenfield** and his wife Nancy Liebman, '71, moved to Stony Brook, N.Y. in July of this year. Don is an assistant professor in the urban and policy sciences program at S.U.N.Y. at Stony Brook. . . . **Russell Molari** reports he is "growing up again for the third time, I never expect to become an adult." He is enjoying California's sunshine and music while making Pioneer satellites for N.A.S.A. . . . **Irene Chang** is now a nuclear engineer with the Atomic Energy Commission in Bethesda, Md. Irene's responsibilities include working on water reactor safety problems. . . . On January 23, 1974, **Eugene F. Mallove** and wife Joanne were blessed with a daughter Kimberlyn Beth. He is completing his doctoral thesis at the Harvard Department of Environmental Health Sciences. In his spare time, he investigates U.F.O. reports. . . . On June 23, 1974, **Shelley Fleet** was married to Dr. Edward Steven Ackerman (Harvard '68, U.C. at Irvine School of Medicine '73). They are now living in Stockton, Calif. where Shelley is completing her medical studies and Ed is a resident. Their tentative plans upon completion of their current studies is to return to Boston with Shelley in anesthesia and Ed in neurology. Shelley reports having seen **Kendall Marr** and **Lee Brettman** in Cleveland where both are interns. . . . **George Hustak** writes that living at the beach in Los Angeles is great. He says "hello" to all members of the 1969 Lacrosse team—the "best ever"—and invites them to stop in if they are in the area. George also informs all Delts that **Art Thrash** is alive and well and will be resurrected at Moorman's wedding. . . . **Lee Van Slyke** is now a consulting actuary with offices at 173 Cambria Avenue in Ventura, Calif. . . . **Christopher R. Ryan** and his wife Janis have moved to Murrysville, Pa. He is working with a new French-American foundation construction firm whose president is former M.I.T. Professor David D'Appolonia. . . . **M. M. Franckiewicz, Jr.** graduated from the University of Chicago Law School in June of 1973. After passing the Pennsylvania state bar exam, he is now an attorney for the National Labor Relations Board in Pittsburgh, Pa. . . . **Sharon F. Grundfest** has just completed a year as the first woman surgical intern at Roosevelt Hospital in New York City where she is now a resident in general surgery. She lives near Lincoln Center and has seen many performances as "house doctor." . . . **Arthur C. Polansky** is working as a chemistry-physics-earth science-computer lab instructor at Groton School and is enjoying it immensely. Arthur writes "it's much more fun not being a capitalist."

It is with deep regret that I report the death of another classmate, **John Michael Gonsiewski** who died unexpectedly on February 23, 1974, of a heart failure. Late last year John had taken a position as an engineer with Lockheed Missiles and Space Company in Sunnyvale, Calif. He was also completing his Ph.D. in aeronautics at Stanford University which he had attended since his graduation from M.I.T. in 1969. John had been elected to the Palo Alto Unit Board in early 1973. Approximately one year later the Unit Board members elected him their President for the year 1974. He was the co-director of the Tuesday Masters Club in Palo Alto and of the Los Altos Club. In addition to these activities, John had traveled in all but six of the fifty states, and in Europe as a prize from a contest sponsored by a cigarette company. I am informed that contributions to John's memory may be made to the Stanford University Hospital Heart Fund. On behalf of our class, I extend our sincere sympathy to John's family and friends. —**Richard J. Moen**, Secretary-Treasurer, 4008 IDS Tower, 80 South Eighth St., Minneapolis, Minn. 55402

70

No excuses this time for the column's recent absence; I will merely hang my head in shame and implore all you potential letter-writers out there to provide me with inspiration. The summer has been a pleasant one, weather-wise and otherwise, and has included such delightful activities are participating in a sandcastle competition (for the second year) and playing flute for an M.I.T. Community Players original musical adaptation of *Alice in Wonderland*.

We must be getting old; I recall that news used to be of people working through medical school; these days it's about internships and residencies. . . . **Anthony H. Russell** graduated from Harvard Medical School in June and in July began his internship at the University of Virginia Hospital in Charlottesville. . . . **Ronald J. Palinsky**, who graduated from Dartmouth Medical School in June 1973, has completed his year of internship at Cleveland Metropolitan General Hospital. In July he started a 3-year Neurology Residence at Johns Hopkins Hospital in Baltimore, Md. . . . **Glennard S. Ruedisueli** received his M.D. degree from Tufts University in May, and in July began three years of residency training in pediatrics at the Children's Hospital, Columbus, Ohio (affiliated with Ohio State University). . . . **David J. Smith** received his M.D. degree in June from the University of Chicago Pritzker School of Medicine, and in July began his internship at the University of Minnesota in Minneapolis. David plans to specialize in orthopedic surgery.

Hugh C. Masterman is working in the Radar Display Section of Raytheon in Sudbury. Hugh is married and has a daughter, Lisa, who is a year old. . . . **Robert H. Kattef** is alive and well and teaching second grade in Weston, Mass.; he finds seven-year-olds loads of fun. . . . **Thomas H. Derby** is selling "The hottest computer application since payroll—the I.B.M. power management system has saved customers 5-30 percent of their electric bill." Tom is recently married, and has bought a house in Atlanta, where he's having a great time. . . . **Robert J. Fleischer** is completing his third year with the Mitre Corporation in Bedford, Mass. He planned to spend part of his vacation backpacking in the Grand Tetons with his brother and Steve Kofol '71. . . . **Arthur Davidson** is still plugging away for a Ph.D. in applied physics at Harvard, but should be through in another year. His wife of four years, Janis, has a new job at Gardner and Preston Moss in downtown Boston. . . . **Mitchell Swartz** and his father, Allen I. Swartz '50, were judges for the Massachusetts State Science Fair at M.I.T. this spring—probably the only father-son team among the judges this year. Mitchell is continuing graduate study at the 'Tute in the doctoral program in biomedical engineering. . . . **George Biehl** finished his M.Ed. in August and then left for a chemistry teaching position at the American School of Bangkok, Thailand. . . . **Jerome S. Gordon** received an M.S. in psychology from Pennsylvania State University in March. . . . Received a letter from **Wesley F. Moore** who is out in Washington State working for Boeing on a low energy air transport project. He recently visited some other Conner 5 exiles on the West Coast. . . . In Pasadena, he saw Nancy and **David Hall**; Dave is working on a Ph.D. at Cal Tech and not enjoying Los Angeles' smog. . . . In Oakland, Wes visited **Dick Voss**, who is working on a Ph.D. at the University of California at Berkeley ("something about 1/f noise in solid state devices, I think"). Both Dave and Dick were surprised that Wes is enjoying "civilian" life so much and has no intention of going back to school anytime soon. . . . Wes also saw **Mark Weinberg**, who came from Dayton, Ohio, to see Boeing for the Air Force, which owns him for the next few years. . . . And, finally, our congratulations: **Dr. Ronald S. Sheinson** reports that in April his wife Harriet gave birth to their first child, Baruch Eliot. Ron is a research chemist at the Naval Research Lab. in Washington, D.C. No more news this month. If you don't send me some, I'll have to start inventing weird rumors.—**Laura Malin**, Secretary, 82 Munroe Street, Apt. 1C, Somerville, Mass. 02143

71

Here we go again. . . . **Avi Ornstein** is reentering the collegiate circle, having enrolled at Boston State College to take his first education course on the road towards being certified as a teacher. . . . **Richard F. Park** graduated on May 20, 1974, from the University of Pennsylvania Law School in Philadelphia. He is now back in Baltimore, preparing to take the Maryland Bar Exam this summer. He began work in the Trust Department of the Equitable Trust Bank of Baltimore in July . . . **Walter Daub**'s okra enterprise folded some months ago and he's now employed as the sales manager in an exclusive haberdashery in downtown Dallas. . . . **Nazim Kareemi** completed his studies at Stanford University and is working with Systems Controls, Inc. in Palo Alto. . . **A. H. Sims, Jr.** was recently registered as Professional Engineer in the state of New York. He is continuing to serve as senior project engineer for R. G. Vanderweil Engineers, and is still specializing in hospital design . . . **Steve Givot** bought a seat on the Chicago Board Options Exchange and is currently a market-maker there. He gets his MBA in June. **Barb (Lamond) Givot** is a methods engineer at Commonwealth Edison. Both returned from a year at the London School of Economics in September '74.

. . . **Al Smith** quickly wrote: "This letter is written during a short break in the process of grinding out a thesis. I have been working my tail off for the last two months trying to finish up. I will be an assistant professor at Berkeley in the Dept. of Electrical Engineering and Computer Science starting in Sept., and I am desperate to be done by then." . . . **Carol D. Seligson** reports that **Diane Lee Feldman**, who is still working on her Ph.D. in physical chemistry at Columbia University, is going to be married to Barrett Alan Eisenstat. Barry is presently a fourth year medical student at N.Y.U. Medical School. . . . **Ellen S. Cheng Koutsoftas** just received her Master of Architecture from Princeton University and is presently looking for a job in or around The Big Apple. . . . And as for C.D.S. I just, reluctantly, left the great city of N.Y. and am presently residing in Baltimore, because as of Sept. I will be a first year grad student in the Department of History of Science, ostensibly working for a Ph.D., Johns Hopkins University . . . **Lee J. Scheffler**'s instructions to us were: "As for a blurb in *Tech. Review*, something like the following: Lee Scheffler has become a decadent capitalist and joined the military industrial (i.e. computer) complex after finally getting out (of marriage and M.I.T.). He will be living at 22 Centre St., Apt. 1, Cambridge, Mass. 02139. Send him some mail so he feels loved."

. . . We got quite a letter (short story) from **Marc Covitt** bringing us up to date on himself and a bunch of TEPs. The following are excerpts from his photo-copied letter with the personalized salutation of "Dear Whoeveryouare:" "I have returned to California. And after only four weeks of occasionally active searching, I now am re-employed, rehabilitated, and a functional member of the "real world". Since mid-May I've been working at Hewlett-Packard in Palo Alto with the ubiquitous title of Programmer/Analyst. HP makes minicomputers, pocket calculators, measuring instruments, medical-electronics, and a host of other goodies, all of which you probably know, but since I'm using their typewriter I might as well put in a plug. Actually, this is a fine place to work. The pay is excellent, and the benefits include profit-sharing (it feels good to work for a company that actually turns a profit) stock options and such, which amount to about 10% on top of your gross wages. Employees work a flexible hours program, whereby you can pretty much come in whenever you want and leave when you want providing you put in an 8-hour day. At break time or lunch time, people eat their lunch outside, and can then be seen playing volleyball, ping-pong, horseshoes, shuffleboard, frisbee, etc. They also provide 100% reimbursement for business-related schooling (including MBA programs) at Stanford and other area colleges. For those of you who care, I am currently working on a rewrite of the "product file" system, which handles all relevant data (price, descript, etc.) for their world-wide order entry system . . . I'm now living in a large apartment complex called Fair Oaks West in a 1-bedroom apartment. Unfortunately, as of this moment, I am still the only occupant. However, in an effort to console me, the complex has three swimming pools, (one Olympic size), billiard tables, ping-pong, volleyball, sauna, jacuzzi whirlpool, gym, darkroom, woodshop, and that great time-killer PINBALL. Seems as though I spent a lot of time near my apartment but very little inside of it." As for TEPs of all ages Marc wrote: "Through no fault of his own, Alan Chapman '70 is now a holder of the advanced degree of Master of Music Theory. A few more years and he will be the person to see when your theory is sick. Who could believe, Dr. Chapman, the Mustachioed Maestro. . . . Jeff Weisel '70—Soon to be interning in internal medicine in Los Angeles, and I forgot the hospital, but I think it was at Kaiser. Also I just recently learned that Da Weisel got married. Congratulations to Jeff and Kathy, who I met before she was Mrs. Weisel back in Brooklyn in March. . . . Larry Gessman '70—Larry will also be interning in internal medicine, but he will be at Bellevue in New York City. . . . Bob Demarrais '70—Hidden far above Cayuga's waters, Demarrais is writing and recording his theory of catastrophes which explain history using mathematical correlations. It may seem complicated to the laymen, but once you understand the elliptic umbilical and rainbows, everything else falls right into place. He's still doing a few radio spots of "Uncle Bob's Fabulous Facts", and if anyone would like a tape recording explaining what complex numbers *really* are, let me know. In another year it will be PhD. Bob. . . . Barry Bochner '70—When I visited Barry at Ann Arbor, he was upset over the fact that he had to find a new thesis topic and get it accepted. But, the Chimp managed to pull himself away from the labs, long enough to take me to Pizza Loy's for one of the best meals of my trip. If all goes well for the Chimp, cellularly speaking, he, too, will be a PhD. . . . **Ralph Brindis**—I didn't visit Ralph this trip (almost, though, Brindis) but I did call him before I left Hartford. He's finally into medical school at Emory in Atlanta. Ralph's only comment at the time,—"I'm boring. When I play basketball, all I think about is which muscles I'm moving. When I'm not being boring, I'm being (deleted). . . . Scott Mermel '68—Up in the air over Chicago. Scott, Eve, and I saw "Blazing Saddles" my first night in Chicago. The next day Scott and I flew to Milwaukee with Mermel trying to do an imitation of the Bloody Red Baron and convince me that he could successfully pull out of stalls and dives. I'm not sure which event was funnier, but I certainly was not scared at the movie. It seems that Scott and I are in the same business. We are also not doctors. Draw your own conclusions. . . . **Jeff Arnold**—Also not a doctor, also a data processor. He and Shellie are on again, off again. When last I saw him, they were off again, but a recent letter from Lee Scheffler said they were back once more. . . . John Carroll '70—I haven't heard from John in a long time (If he's very busy, Helaine, why don't you write?) but I understand that he's now teaching at the University of Pittsburgh in Psychology. . . . Chris Rose '70—I haven't heard from Chris, either, but he is now interning at Beth Israel in Boston." Somehow, **Marc Barman**, who is neither a TEP nor Marc Covitt, snuck into the letter: "In the small world section, for those of you who like coincidences, I now work with a guy named **Marc Barman**. Not only do we both work for the same boss, we also live in the same apartment complex. It is obvious that the man has good taste, but it is a constant problem in the group that we have the same name spelled the same way."

That's about all for now. We've almost used up our backlog of information, so please write and let us know how and what you're doing.—**Howard Jay** and **Leah Jamieson Siegel**, Class Officers, 228C Harrison St., Princeton, N.J. 08540

72

John Mason writes that he is working on an M.S. in computer science at the University of Utah in Salt Lake City as well as working full time designing computer graphics hardware for the Evans and Sutherland Computer Company. "Despite all that," he continues, "I got in 45 days skiing at Alta and Snowbird this year—only a 40 minute drive from home." . . . **Michael Sims** is attending Albert Einstein Medical College and is a second lieutenant in the air force under the Armed Forces Health Scholarship Program. . . . **Jimmy Chang** is a grad student at the University of Illinois at Urbana in the nuclear engineering department working on plasmas. . . . **Bob Schulte** is returning to Harvard Business School after a year off working for Gillette in South Boston.

Stanley Hoffman writes, "I am a graduate student in biology at Caltech. I am doing research on the membrane of the slime mold, Dictyostelium discoideum. I have been married for a year to the former Barbara Brown, Emmanuel '73. She is working at the Jet Propulsion Lab as a Command System Engineer in the Deep Space Network.

That's it for this month. For those of you who didn't catch it the first time, that's Dictyostelium discoideum.—**Dick Fletcher**, Secretary, 135 West St., Braintree, Mass.

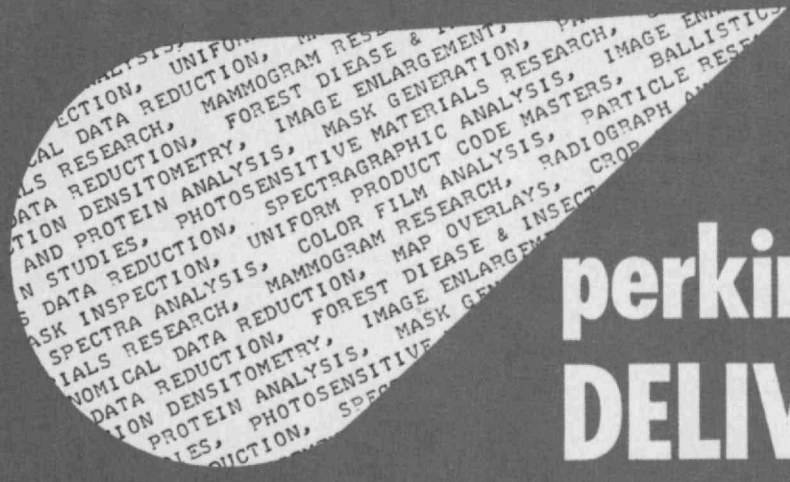
74

I hope everyone has had a nice summer. Now that fall is here the vacation is over and it is back to work. Some people have not yet had a vacation, however. **John Tierney** is working as an actuary at Commercial Union Assurance in Boston. He is engaged to be married August 24 to Kathy Whelan, a recent graduate of Boston University. I've heard from **Andrew Nourse** who is programming at Block Engineering here in Cambridge. Another classmate I ran into is **Charles Bayne** who is "taking a nice long vacation" in Cambridge this year.

Alumni Day '74 followed our graduation and the Class of 1974, although just recently becoming alumni, were represented there by several classmates. These include **Charles Bruno**, **Rick Corey**, **Dee Crouch**, **Philip Doucet**, **Donald L. Grimes**, **Thomsen Hansen**, **Sharon Havens**, **Michael Luebbers Jr.**, **Jeffrey Mayne**, **Gary Raymond** and **Jeffrey C. Weinreb**. You may know a few of these people. Then again, you may not.

The reason for this shortage of news is that your cards and letters are not streaming in as they should be. I'll be lucky if I have a five-minute backlog. Hopefully the situation will change. Just send a letter. You can send photographs, too. I guarantee to print them. As for myself, I will be starting Harvard School of Design in September for a master's in city planning. So what are you doing?—**Dennis Dickstein**, Secretary-Treasurer, 23 Howard St., Cambridge, Mass.

digital image processing DEMANDS and



perkin-elmer DELIVERS

the ultimate in photometric and geometric accuracy and repeatability

In order to reconstruct an improved image, you must be able to record every detail, down to film granularity and beyond.

Photo Material Research is one of the prime applications of our PDS Data Acquisition Systems. Doesn't it make sense? To properly process an image—your input and playback capabilities must be media limited, not instrumentation limited.

The large number of PDS Microdensitometer Systems now successfully performing in the field attest to this capability.

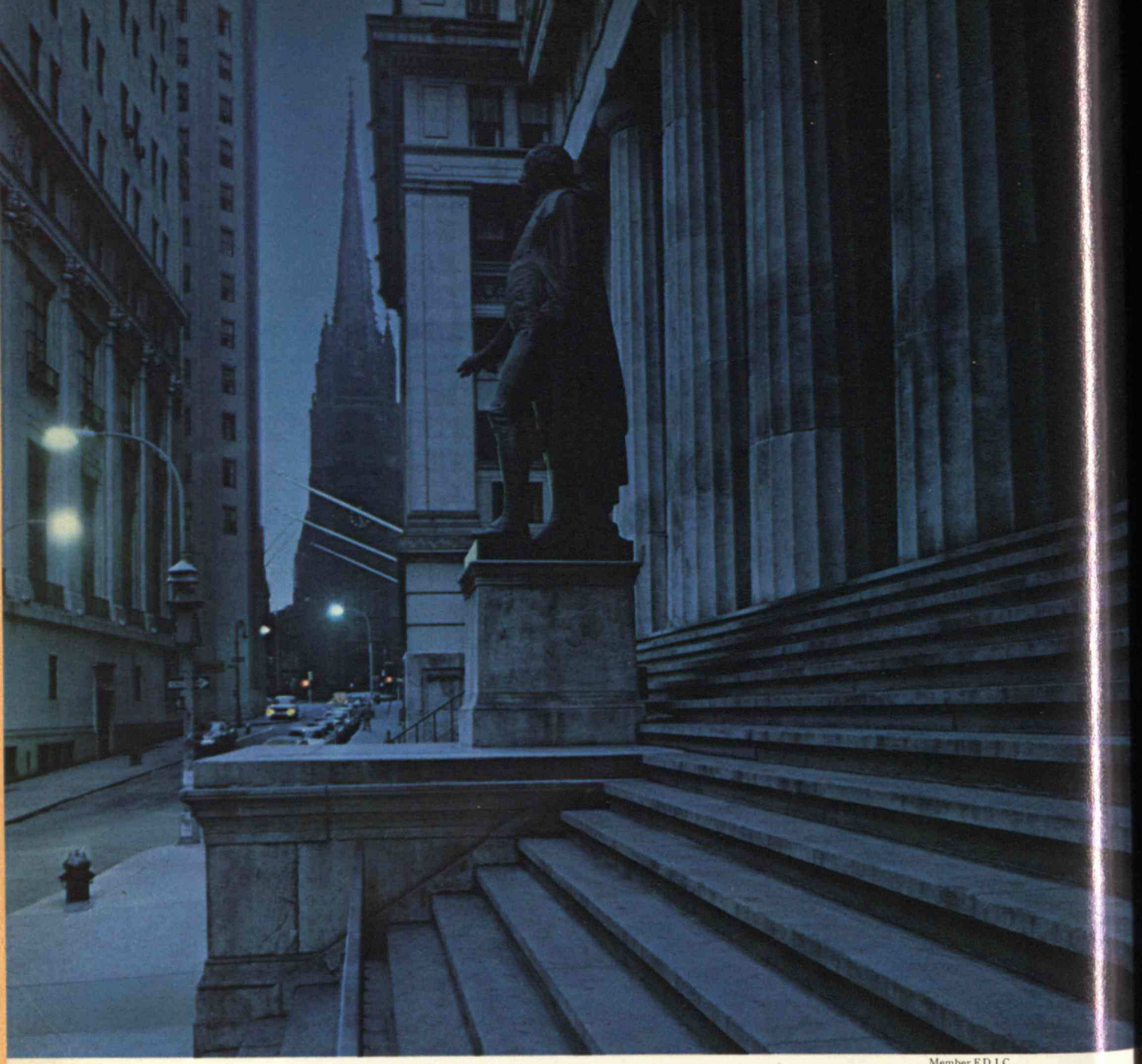
PERKIN-ELMER supplies fully interfaced and working systems. We assume full systems responsibility. Proof of performance to all listed specifications is supplied with installation. Operational and Test Software is provided.

We would enjoy discussing your possible application. Please call or write for X-1010 Brochure, to:

Boller & Chivens Division — where precision is a way of life.

PERKIN-ELMER

916 MERIDIAN AVENUE • SOUTH PASADENA, CALIFORNIA 91030



Member F.D.I.C.

Even overnight, your company's dollars should be working in the money market. Let Citibank show you how.

Anytime you have corporate funds to invest, you will find a special helpfulness in Citibank's Money Market Division. Today's market is difficult to follow because there are more and more instruments available; and because rates, risks, and yield relationships are changing so rapidly.

One specialized unit of our division serves only corporations such as yours. That is why so many companies turn to First National City Bank for investments and counseling. This "one-place-to-shop" service can put you quickly and knowledgeably into any appropriate instrument, at the proper time, and at an advantageous price.

Our corporation specialists work with virtually every kind of money market instrument—not only U.S. Government obligations (such as Treasury Bills, Notes and Government Agencies), but Bankers' Acceptances, Repurchases, Certificates of Deposit, Commercial Paper and Municipal Securities as well. Our people are up-to-the-minute on all money market trends and developments. This means only one phone call in a market where minutes can make a difference.

Physically, as well as professionally, we are at the heart of the market (95 Wall Street, to be precise). And being part of a bank that's active in every major money market, worldwide, adds a significant dimension to our perspective.

If you are a corporate financial executive who likes to sleep nights, make sure your dollars don't. For more information on our money market operations, just get in touch with your Citibanker.

FIRST NATIONAL CITY BANK
Businessmen everywhere call us "Citibank"

95 Wall Street, New York, N.Y. 10015